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THE PALÆONTOLOGICAL EVIDENCE FOR THE TRANSMISSION OF ACQUIRED CHARACTERS.[1]

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AS a contribution to the present discussion upon the inheritance of acquired characters I offer an outline of the opinions prevailing among American naturalists of the so-called Neo-Lamarckian school, and especially desire to direct attention to the character of the evidence for these opinions. This evidence is of a different order from that discussed in Weissmann's Essays upon Heredity, and while it cannot be said to conclusively demonstrate the truth of the Lamarckian principle, it certainly admits of no other interpretation at present, and lends the support of direct observation to some of the weightiest theoretical difficulties in the pure selection principle.

1. I regard natural selection as a universal principle, explaining the "survival of the fittest" individuals and natural groups, and as the only explanation that can be offered of the origin of one class of useful and adaptive characters. I supplement this by the Lamarckian principle as explaining the "origin of the fittest" in so far as fitness includes those race variations which correspond to the modifications in the individual springing from internal reactions to the influences of environment.

[1] A paper presented to the British Association for the Advancement of Science, Newcastle, Sept. 11th, 1889. Section of Biology. Also read before the American Association for the Advancement of Science, Toronto, Sept. 2. Printed, not previously published.

There is naturally a diversity of opinion as to how far each of these principles is operative; not that they conflict.

2. If both principles operate upon the origin of the fittest we should find in every individual two classes of variation, both in respect to new characters and to modifications of the old:—First, chance variations, or those which, with Darwin and Weissmann, I attribute to the mixture of two diverse hereditary strains. These may or may not be useful; if useful they depend entirely upon selection for their preservation. Second, variations which follow from their incipient stages a certain definite direction towards adaptation. These are not useful at the start; thus while, as they accumulate, they favor the individual, they are not directly dependent upon selection for their preservation. These I attribute to the Lamarckian principle.

My present purpose is to show that variations of the second class are of an extent and importance not suspected previous to our recent palæontological discoveries, and that the Lamarckian principle offers the only adequate explanation for them.

3. The general theory as to the introduction and transmission of variations of the second class may be stated as based upon the data of palæontology — the evolution of the skeleton and teeth.

In the life of the individual, adaptation is increased by local and general metatrophic changes, of necessity correlated, which take place most rapidly in the regions of least perfect adaptation, since here the reactions are greatest. The main trend of variation is determined not by the transmission of the full adaptive modifications themselves, as Lamarck supposed, but of the disposition to adaptive atrophy or hypertrophy at certain points. The variations thus arising are accumulated by the selection of the individuals in which they are most marked, and by the extinction of inadaptive natural groups. Selection, in so far as it affects these variations, is not of single characters, but of the *ensemble* of characters.

The evidence is of a direct and indirect character. The direct evidence is that by actual observation in complete palæontological series, the origin of adaptive structures is found to conform

strictly to the lines of use and disuse. The indirect proof is that the natural selection of chance variations is unsupported by observation and is inadequate to explain the variation phenomena of the second class.

4. I will first briefly consider the former. The distinctive feature of palæontological evidence is that it covers the entire pedigree of variations, the rise of useful structures not only from their minute, apparently useful condition, but from the period before they appear. The teeth of the mammalia render us the most direct service, as compared with the feet, since they furnish not only the most interesting correlations and readjustments, but the successive addition of new elements. With a few exceptions which need not be noted here, all the mammalia started with teeth of the simple conical type—like the simple cusps of reptiles. Practically every stage between this single cusp and the elaborate multicusped recent molars is now known. Every one of the six main cusps of the molar of *Hyracotherium*, for example, a type of an important central stage in the ungulate dentition, is first indicated at the first point of contact or extreme wear between the upper and lower molars; this point of wear is replaced by a minute tubercle, which grows into a prominent cusp. These are the laws of cusp development, as observed in every known phylum of mammalia:

I.—The primary cusps first appear as cuspules, or minute cones, at the first points of contact between the upper and lower molars in the vertical motions of the jaws.

II.—The modeling of cusps into new forms, and the acquisition of secondary position, is a concomitant of interference in the horizontal motions of the jaws.

5. The evidence, of which this is only a single illustration, has accumulated very slowly. The line of reasoning from this particular series of observations is as follows: 1. The new main variations, in the teeth and skeleton of every complete series, are observed to follow certain definite purposive lines. 2. By careful analysis of the reactions to environment which would occur in the individuals by the laws of growth, we observe that the race variations strictly conform to the line of these reactions. 3.

We further observe that no variations of this class occur without the antecedent operation of these reactions; the working hypothesis thus stands the test of prediction. 4. We accept this invariable sequence of race adaptation upon individual adaptation as proof of a causal relationship.

6. I admit that this proof may be invalidated in several ways: 1. By showing in more extended research that these observations of sequence are inaccurate or offset by others in which there is no such sequence. 2. By showing that the Lamarckian principle, while explaining some of the variations of this class, is directly contradictory to others. 3. By showing that all these phenomena may be explained equally well or better by natural selection. 4. By proving, independently, that the transmission of acquired characters never occurs.

I will now consider each of these cases:

First.—As regards these observations. They may be examined in detail in the studies of Cope, Wortman, or Ryder, and in a paper I presented to this Association last year. As the question of transmission has been generally assumed in the foregoing studies, I think it is now important to review the whole field, searching for facts which look against the Lamarckian principle, for as we have been hitherto studying with a *bias* in favor of it, some such adverse points may have been overlooked. At present, however, I can recall only a single adverse observation, that is, in the development of one of the upper cusps, the lower cusp which opposes it, and which is therefore supposed to stimulate this development, is found to recede. I have no doubt others will be found presenting similar difficulties.

Second.—As regards the Lamarckian principle. Several objections to the special application of this principle to the evolution of the teeth have been raised by Mr. E. B. Poulton:

A.—To the objection that the teeth are entirely formed before piercing the gum, and that use produces an actual loss of tissue as contrasted with the growth of bone, it may be said that by our theory it is not the growth itself, but the reactions which produce this growth in the living tissue, which we suppose to be transmitted.

B.—To the objection that this proves too much,—that the cusps thus formed would keep on growing, it may be said (*a*), that in the organism itself these reactions occur least in the best adapted structures. This proposition is difficult to demonstrate in the case of the teeth, but may be readily demonstrated in what are known as the phenomena of displacement in the carpals and tarsals where growth has a direct ratio to impact and strain. (*b*), In the organism itself growth does not take place beyond the limits of adaptation; there is, therefore, no ground for the supposition that overgrowth will take place by transmission. (*c*), Either by the selection or Lamarckian theory development is held in check by competition between the parts; there is a limit to the nutritive supply; in the teeth, as elsewhere, the hypertrophy of one part necessitates atrophy of another.

C.—A general objection of considerable force is that we find other adaptations, equally perfect, in which the Lamarckian principle does not apply; why then invoke it here? To this it may be said that there is no theoretical difficulty in supposing that while natural selection is operating directly upon variations of the first class, the Lamarckian principle is producing variations of the second class, and while selection does explain the former, it falls far short of explaining the latter.

D.—Finally, if Weissmann succeeds in invalidating the supposed proofs of the Lamarckian principle derived from pathology and mutilations, this will not affect the argument from palæontology and comparative anatomy, for these proofs involve two elements which are not in our theorem: (*a*), immediate transmission of characters; (*b*), transmission of characters impressed upon the organism and not self-acquired.

Third.—As regards the adequacy of the selection principle to explain these variation phenomena. It is not necessary to repeat here the well-known current theoretical objections to this principle, but simply to point out the bearing of this palæontological evidence. In Weissmann's variation theory the preponderating influence must be conservative; however it may explain progressive modification, or even correlation of old characters, it does not admit that the genesis of new characters should follow definite

lines of adaptations which are not preëxistent in the germ plasma. We find that new characters of the second class do follow such purposive or directive lines, arising simultaneously in all parts of the organism, and first appearing in such minute form that we have no reason to suppose that they can be acted upon by selection. The old view of nature's choice between two single characters, one adaptive, the other not adaptive, must be abandoned, since the latter do not exist in the second class.

Fourth.—The most serious obstacle to the Lamarckian principle is the problem of transmission. How can peripheral influences be transmitted in the way we have outlined—now that we have such strong evidence for the continuity of the germ plasma? If acquired characters are not transmitted it is clear that the whole Lamarckian principle is undermined, and all these instances of sequence express no causal relationship. We are then, however, left without any adequate explanation of the laws of variations of the second class, and are thus driven to postulate some third, as yet unknown, factor in evolution to replace the Lamarckian principle.

METHODS AND MODELS IN GEOGRAPHIC TEACHING.[1]

BY WILLIAM M. DAVIS.

IN presenting to the Association certain considerations regarding methods of teaching geography, I venture to assume that your interests in educational matters extend so far down as to reach a subject which many scholars "finish" early in their course, and whose advanced study hardly receives its due place in our colleges; certainly it has suffered from neglect. My own practice in the way of teaching it has been with college students in the division of physical geography, and not feeling entirely satisfied with the system of study as presented in the text-books in current use, I have endeavored to discover and supply certain elements by which instruction in the subject might be advanced.

[1] A lecture delivered before the Scientific Association of Johns Hopkins University, on February 13, 1889.

The first element that should be supplied is one by which the conceptions which the teacher has in mind can be vividly transferred to the student. The teacher bases his mental pictures on something that he has seen, if he is so fortunate as to have traveled and brought home with him fresh memories of the morphology of the earth's surface; or if not an observer himself, he has at least had time to gain his geographic conceptions slowly, and with the aid of various descriptions and illustrations that he cannot present in their entirety to his class. How shall his ideas be passed on to his students? Maps and pictures are of value, but as a rule they are of low quality, except for the larger parts of the world. They present no sufficient expression of the forms of moderate size on which we live. Photographs are excellent as illustrations of actual landscapes, yet they are too often chosen with other than geographic reasons for the choice, and but few schools have them in sufficient variety. Moreover, all these aids lack one element of great value, namely, the third dimension that so strongly characterizes all geographic forms. I have therefore desired to use geographic models, which very easily give clear indication of the relief of a surface, and if without all its detail, still possess effective and suggestive form. Models are therefore to be taken as one of the means of improving the methods of illustrating what the teacher wishes to place before the class.

Again, physical geography as ordinarily defined is too largely merely descriptive, and not physical at all. Indeed, geography, which is supposed to treat of the form of the surface of the earth, neglects the form of the earth's surface to an unfortunate extent. We hear much about the connection between geography and history, for example; but what is this subject that is connected with history? Where is geography itself taught with the same thoroughness that characterizes the modern teaching of the biological sciences? We recognize of course the vital connection between geography and history, just as the botanist recognizes the connection between botany and medicine, but what botanist would be satisfied with stopping his teaching of his science or even of only its elements at the point that would suffice for the collector of medical herbs, or for the doctor of medicine? And

why should the geographer be satisfied with so brief an outline of his science as will suffice for illustrating its connection with history? The subject deserves study for its own worthy self; it is in this line that the teacher of geography must wish to see it developed, and it is to this end that he must strive, just as his colleagues strive to advance the study of their respective sciences for their own sake, and not merely for the illustration of some other. For this reason I have endeavored to examine the forms of the land surface in detail, and to arrange them in their genetic relations, in order to come to a closer appreciation of the meaning of the form of the earth and its development. In this way, it seems to me, we may best study the fundamental material of geography. A year ago I had the pleasure of presenting some outline of a geographic classification at a meeting of the National Geographic Society in Washington, and now I would add thereto some account of certain geographic models,[1] designed as a means of illustrating this classification. Some of the models illustrate the development of plains and plateaus; some present the various forms of volcanic cones and lava flows; others indicate the changes in the features of a river as it grows old, or as it is embarrassed by glacial or volcanic accidents. You will perceive, in considering the use of these models, that it is essential that we should study the surface of the land by means of types, for it would be as impossible for a scholar to learn all the individual forms of the land as it would for the young botanist to learn all the individual plants of the world, especially if they were brought before him in the order of their occurrence over the world, and not in accordance with some well-tried system of logical and natural classification. Botanists and zoölogists believe that it is time enough for their scholars to study the complex congeries of forms that constitute the fauna or flora of a country when they have mastered the rudiments of the subject by careful study of a moderate number of typical examples of plants or animals; and, indeed, in the modern development of

[1] The originals of these models were designed by me for use in a course of lectures before the Teachers' School of Science in Boston in 1888; copies of them have been prepared by Mr. J. H. Emerton, Boston Society of Natural History.

the study of biology, one may see the strongest contrast with the older methods in this respect. I should be glad to see a similar change overtake the conservative science to which my studies are devoted.

In order to give specific illustration of the method of study by geographical types and the use of models, let me ask your consideration of that large group of land-forms that may be included in the category of plains, plateaus, and other derivatives. There is a brief preliminary consideration.

Any mass of land constituting a single geographic individual or a natural group of such individuals, must, as soon as it is exposed to the destructive forces of the atmosphere, begin its long sequence of development; and if no change of level happen to it, it must at length be worn down smooth and low to a featureless plain. When this work begins, with every mark of immaturity in its small accomplishment, we may regard the individual as young; that is, but little advanced in the long cycle of systematic change through which it is destined to pass. When much more work has been accomplished, and the variety of form resulting is at its greatest, the individual may be called mature; and finally, when the features of maturity weaken as the relief is reduced and intensity of form is lost, we find a resemblance to organic decay, and are warranted in the use of such a term as old age.[1]

But you may say that all this is geology, not geography. Geological processes are indeed at work in carrying the geographic individual through its successive forms, but we are not concerned with the processes, only with the results. In organic growth, the process is chemical; but for all that, biology is not chemistry. Moreover, if the several forms assumed by a geographic individual are geological affairs, we might expect to find them treated in the standard works on that science, but, except in brief outline, nowhere do they appear in such books. Geology is quite enough occupied with matters of underground structure,

[1] The example of a form in its "old age," as that term is employed by Chamberlin and Salisbury (Sixth Ann. U. S. Geological Survey), would in the above scheme be called "mature," for it still possesses abundant relief, and is by no means a featureless base-level plain.

with questions of constructive and destructive processes, and with composition and fossil contents of rocks to be awake to another large question. The study of the form of the earth's surface, even though recognizing that the form changes, is geography. But after all, geography and geology are one science, treating of the earth, and it is needless for us to embarrass our work by attempting unnecessary subdivision and limitation of the fields that the two branches shall occupy. Let each one take whatever will aid its attainment of the desired end. If we can understand geographical morphology better by some consideration of geological structure, let it be introduced, just as chemistry is introduced into physiology, or physics into meteorology. Surely geologists have employed geographical methods freely enough to warrant our reversing the relation. If some consideration of geological processes will serve our purpose and give better appreciation of the sequence of forms that geographical individuals pass through, then call freely on geology for such consideration and use it to the best advantage. Do not hamper our endeavor to understand the form of the earth's surface by any arbitrary limitation of the means that we shall employ to the end. It is plainly apparent that geology and geography are parts of one great subject, as ancient and modern history are, and they must not be considered independently. Indeed, it is only in this close relation that a satisfactory definition of the two terrestrial sciences is obtained. Mackinder has concisely said that geology is the study of the past considered in the light of the present, and geography is the study of the present considered in the light of the past. I can quote no better indication of the close connection of the two divisions of the world's history. Without going further into abstract considerations, we may now turn to our concrete examples.

The so-called "valley" of the Red River of the North in Minnesota and Dakota is a broad plain of exceedingly level surface. It is so truly level that it illustrates the curvature of the earth, in the same way that it is seen at sea; for in crossing the plain first a distant tree-top is seen above the horizon, then a house-top, and at last the body of the house rises into full view; just as the upper and lower sails and the hull of a ship are

brought into sight in sailing towards it on the ocean. This broad plain is a lake bottom, whence the water in which its fine sediments were laid down has been drained away, and drained away by so curious a process that if, in teaching modern history, it were noted that some existing form of government were as curiously related to the past, no teacher would hesitate to make reference to it. The northern barrier that held the waters of the lake was the southward front-slope of a great sheet of ice that for a time obstructed the open northward drainage; and in the lake thus created fine sediments were spread out so plentifully that they buried the former surface of the land, and so evenly that when the waters were drained away as the ice melted a dead-level plain was revealed.

The plain stands well above sea-level, and hence must suffer change as destructive processes attack it. Why then is it so smooth? Manifestly because it is young. There has not yet been time for streams to channel it. It is extremely immature, truly infantile in its appearance, with scarcely a sign of the variety of features that will be developed in its later history. Does not this consideration lend additional interest to the study of so simple and monotonous a district as the plain of the Red River of the North? Is there not a keener appreciation of its peculiarities gained by looking at them in the light of their development, instead of describing them simply as absolute forms, not otherwise considered.

The Red River plain has, however, begun its development. The Red River itself has incised a narrow, steep-sided trench twenty or forty feet deep in the surface of the plain, and the few side branches of the river have narrower and shallower channels. These trenches and channels are simply young valleys, and they are growing so rapidly that their increase in length and width is noticeable even in the past few years of settlement. But still the streams have barely made a beginning of the great work of carrying away all the material of the plain above base-level, this being their manifest future task. So little has been done as yet in the way of preparing drainage-channels that the rain which falls here is greatly delayed in reaching a stream-course by which

it may flow to its goal, the sea, and so much of it stands about idly, instead of quickly running off, that it is in good part evaporated and carried away through the air. Evidently we have here to do with a geographic individual that is just entering its career, that still retains its embryonic characteristics, so little has it advanced in its life-history.

Can we not foretell something of the future history of this plain? As the rivers carve their trenches deeper and deeper, and the enclosing slopes are wasted away and widen out, and the little side-gullies eat backwards and increase in length till they become ravines and the ravines grow into valleys, then the inter-stream surface, at first smooth and unbroken, is traversed in all directions by branching water-courses; the rainfall is much more quickly led into the streams,—everything marks a more advanced stage, all of whose features are indicated in one of the models of the plain and plateau series. But we can not only predict the future of the Red River plains; we can find examples of other plains, born at an earlier time, that are now in the advanced stage that the Red River plains have yet to reach. Look at the coastal plains of the Carolinas. They are the old bottom of the Atlantic, laid bare by a relative uplift of continent. They are well drained; many streams run across them and many branches give ready discharge to the rainfall; the channels are deeper below the general level of the country than are those of the Red River plains, and the inter-stream surface is much more broken; yet still enough of it remains to make it clear the present form is developed from an originally level, unbroken plain; and a close comparison will leave no doubt that the coastal plains of the Carolinas differ from the Red River plains chiefly in being farther advanced in their cycle of development. They are closely related individuals, but they differ somewhat in age. They are like the egg of a caterpillar and the caterpillar itself; not very similar at first, and not like what they will come to be later on, but closely comparable for all that; their differences only manifest their relationship; what one is, the other will be; what the other is the first has been. Thus we can introduce into geography the element of growth, that is, systematic change,

and greatly to the enlivenment of the study. It is often the reproach of geography that it does not deal with things having life; but this is true only if we do not take heed of the kind of life that it may consider. One may say that the changes here discussed are so slow that we need not take account of them; but this is predetermining what we shall and what we shall not study; let us rather see if the consideration of slow geographic life does not impart new meaning to an old study; let us question if this new meaning is not nearer the truth that we are striving for; then we shall be better in a position to judge if slowness of change is a reason for its neglect. No one makes objection to teaching a young scholar about the growth of an oak tree from an acorn, though it is safe to say that no scholar comes to the belief of the growth of an oak from witnessing it; he is convinced of a change that he cannot wait to see, partly by comparison with trees of a faster growth, and partly by seeing oaks of different sizes, and being led to make reasonable generalizations on his observations. It is the same with our understanding of geographic growth; we cannot see much of it, not even the oldest of us, and yet, after the conception is once gained, it becomes so vivid that one can hardly help expecting to find that a change is perceptible on returning after a time to some familiar locality. One may see a sand-bank washed away by a heavy rain, and from this to the washing down of the largest mountain there is only a difference of degree, not of kind. A scholar may easily comprehend the change of form indicated by the differences between the two plains already described, and unless his natural intelligence is obstructed, he can then grasp the idea of geographic growth.

Let us next look at West Virginia, typified in the second model of the series; here the inter-stream hills are so high that they almost merit the name of mountains; the stream branches have become so numerous that no part of the original level upland surface remains; every part has an immediate slope to a stream, and the drainage system is advanced to its highest development. Indeed, we need some aid here from geology to be sure that we are dealing with an individual of the same kind as those already considered, so little likeness is there between this

one and the others. But the aid from geology is conclusive; for West Virginia and a large area around it is made up of horizontal layers of bedded rocks that once were at the bottom of the sea, and that still retain the essentially horizontal attitude in which they were laid down: the whole mass of horizontal layers has simply been raised with respect to the surface of its parent ocean.[1] This elevation is so long ago that the immaturity such as still characterizes the Red River plains is here long past; the adolescence seen in the Carolina plains is also long ago lived through. In West Virginia we have maturity; there can be no greater variety of form than is here presented. The relief of the surface is at its highest value, for while the inter-stream hills have not lost much of their original height, the valleys have been sunk about as low as they can be, and hence there is the greatest possible difference of altitude between hill-top and valley-bottom. The streams have become very numerous, and can hardly be more so; every part of the surface is intersected by them. There is no room for more.

From this time on the form of the surface becomes less pronounced. As the destructive changes progress further, the valleys can deepen but little, although the hill-tops must be reduced, and the valley-slopes must widen out, and all the topographic expression must weaken as old age is approached. This is the character of central Kentucky, and appears in the third model of the set. Excepting where the valleys are enclosed in especially hard rocks, they are wide open, and the variable height of the intervening hills makes it clear that they retain no longer all of the height that they once possessed. They are weakening, passing into forms of less and less emphasis, losing variety, becoming old and feeble.

In the next stage, we may expect to find the valleys so far widened that they should form broad plains, smoothly rolling, essentially a low-land of faint relief, but occasionally diversified

[1] In speaking here of relative changes of level between land and sea, I do not wish to raise the question as to how the level was changed; except to say that the teachings of Suess and Penck in this matter seem to me to go too far in excluding unknown possibilities of broad changes of level, without folding, in the crust of the earth, and without local changes of gravity, on which these authors depend.

with hills of moderate height; and thus the very opposite of the Caroline plains, where the surface is an upland, with occasional valleys. Such an old plain may be seen about the head-waters of the Missouri, in eastern Montana; the general surface is extremely monotonous, gently rolling, and one roll like the next, so that one may easily lose his way in the absence of landmarks. But here and there over the plain mesas of considerable elevation still remain, the reason for their endurance being seen in the layer of hard lava that protects them, and retards their destruction, while the rest of the country not thus protected has wasted away more rapidly. These lava-caps are old flows from once active volcanoes; the lava at the time of eruption undoubtedly ran down from its vents to the lowest ground that it could find; and yet it now occupies the highest ground, in virtue of its obstinate refusal to waste away. Every such lava-cap is an outspoken witness to the greater mass of material over the whole country when the eruption took place, and the destruction of this greater mass must have progressed through the several stages illustrated by the present condition of the Red River plains, the Carolina plains, the mountains of West Virginia, and the hills of central Kentucky, before it could have reached a surface of faint relief. It requires great faith in the evidence here adduced to believe that so stupendous a piece of work has really been accomplished. It is well nigh incredible, and the observer on the ground is fully justified in doubting it as long as he can; but it cannot be doubted when the evidence is once well seized. It is by no means unparalleled, and much nearer home we may find examples as extraordinary, and as far from easy belief, but as necessary to the convictions of the well-ordered geographer.

Such a plain as that of the upper Missouri may be called a base-level plain, because it has been worn down to the controlling level of drainage, or to what is called the base-level of the region; this being in distinction to a constructional or new plain, whose smoothness is due to the short time that its original form has been exposed to developing agencies. A base-level plain represents the ultimate stage in the sequence of a simple cycle of development.

Certain elements of importance yet remain to be considered. If the plain be raised to a moderate height over sea-level, it can never acquire great intensity of relief; for the streams are then allowed but a small depth to which they can cut. If, on the other hand, the elevation is great, and rapid enough to be for the most part acquired before the destructive processes have made great headway, then the vertical element is strong, the topographic relief is intense. Our coastal plain is an example of a region of mild form; it has but slight elevation, and hence however long the rivers flow across it they can never cut out deep valleys. The plateaus of Utah and adjacent parts of the west are of another sort; here the elevation is excessive, and the depth of cutting allowed to the rivers is correspondingly great. Marvelously have they taken advantage of their opportuity. The valley cut by the Colorado and its tributaries is in some places a mile deep, and yet, when we see the enormous mass of land still lying on either side of the valley above base-level, and waiting to be carried down to the ocean, we cannot doubt that the time thus far employed in doing so great a piece of work is a small part of the whole cycle of growth. The upper plateau surface is still broadly level, except for certain irregularities to be referred to later on; the valley is narrow even to notoriety, and must therefore be called young. It is a case of precocious adolescence. Intensity or faintness of relief are therefore variations on the general scheme, and it is my intention that these variations shall also be represented by models when new members are added to complete the present series: a young plateau of intense relief, a middle-aged plain of mild relief, will thus become definitely intelligible terms to our mind. Along with this, it must be perceived that two mature plains need not be of the same age, if measured in years: for the development of maturity in a high plateau requires more time than in a lowland.

There is another element of variation that must be considered. Sometimes the simple cycle of development that has been described is interrupted: the land does not lie quiet long enough to pass through a complete series of changes without disturbance. Indeed, this interruption is, except in very young plains, the

rule and not the exception; and several of the examples already given illustrate it. The coastal plain of the Carolinas has suffered a moderate depression since its valleys were defined pretty much in their present form, and their lower courses are thereby slightly submerged. Thus arise the estuaries that characterize our Atlantic coast, and these are presented in the fourth model. The old base-level plain of the upper Missouri no longer stands at the low level in which it was worn down, but has been elevated a thousand feet or more, and hence all its rivers that had settled down to a quiet old age of little work, have been rejuvenated, and are now beginning a second cycle of life. They run swiftly, in well-defined, narrow valleys, even though the enclosing rocks are soft; and they are sometimes interrupted by waterfalls, even when their volume is as large as that of the Missouri above Fort Benton. Manifestly, therefore, the elevation of the old plain is relatively recent; very little advance has yet been made in the development of its second cycle. The same kind of complexity appears in the high plateaus of Utah and Colorado: the high-level surface in which the cañons are cut is not an original surface of construction, but is a surface of considerable irregularity, as has already been mentioned; part of the irregularity is due to great fractures which have broken the country into massive blocks and lifted them a little unevenly, and part is due to the incomplete base leveling of the region during a previous cycle of development, when the elevation was less than now. The combination of old and new forms thus explained is the subject of the fifth model. A wonderful addition is made to our appreciation of a country when all these factors in its history are recognized as contributing essentially to its topography.

Is it not worth while to try to acquire the broader comprehension of geography that comes from understanding its meaning? Can we not make immediate practical use of such terms as infantile, young, adolescent, mature or middle-aged, old, and very old? Do they not recall all the significance of certain selected or idealized typical examples that have been studied, being in this like the terms that the botanist employs to so great advantage? No botanist would admit the superiority of paraphrases over

terms; compactness, accuracy, and intelligibility would all be sacrificed if terms were given up. And yet nearly all geographers employ paraphrases instead of terms. Let us take an example to illustrate this from the description of certain counties in Missouri in one of the geological reports on that state, to which as in other states we must generally go for the best geographic materials.

The region is one of horizontal structure, and therefore comes under the general heading now considered. Of Miller county it is said:[1] "Near the Osage and its larger tributaries, the country is generally very broken and rocky, excepting immediately in the valleys; but farther back the slopes usually become more gentle, with fewer exposures of rock, until we reach the higher districts, more remote from the streams, where the surface is comparatively level, or but slightly undulating." Again, of Morgan county: "The surface of the elevated region near the middle of the county is beautiful, comparatively level or undulating prairie land. South of this the slopes are first gentle, near the head branches of the Gravois, but as we descend these the face of the country becomes more hilly, and almost everywhere near that and the main creeks, as well as their principal tributaries, and especially near the Osage, it is very broken and rocky. North of the main divide, the high, nearly level prairie land extends, with a slight descent, for some distance northward between the streams flowing in that direction, but near most of the larger streams the surface is more or less broken, and sometimes rocky, but generally not so much so as on the south side."

What is meant by this? Manifestly, the country is an adolescent plain of moderate intensity of development and apparently of simple history. The horizontal attitude of the rocks and the level surface of the uplands show us that the region belongs to the family of plains or plateaus; the irregular courses of the streams and the steepness of their banks decide with equal clearness that the development of the plain has not advanced very far.

Now in the same report the writer says that there are oak trees

[1] Reports on the Geological Survey of the State of Missouri, 1855–1871, (1873); the above extracts being from county reports by Meek, pp. 112, 135, 136.

in the forests. Why does he not say that there are tall vegetable growths, of irregular bifurcations, bearing green appendages at the attenuated extremities, these appendages being strongly scalloped in outline, and so on. He also speaks of pines. Why not of other vegetable growths, with straight vertical axes, from which lateral arms spread out with some regularity, bearing long slender spicules on their minuter divisions. Instead of this, he says oak and pine. This is not because all oaks and all pines are of precisely one pattern. Their variations are infinite, but for all that they vary only througn a moderate range, and can all be brought under typical forms. They may be young or old, large or small, well grown or deformed, living or dead, but they are still oaks or pines. How well it is, therefore, that they should be known by a definite term or name. How well it would be if geographic forms were equally well named; and why should they not be? The many plains that we have described do not differ more greatly among themselves than the oaks or the pines; they deserve recognition as constituting a family, naturally related, not by inheritance from descent, as with the trees, but by similarity of the physical processes under which they have been developed. The natural association of their features deserves just such recognition as is implied by giving them names, distinctive and well defined.

Do we not gain a better understanding of the earth's surface, of the primary object of geographical study, by thus looking at the meaning of land form, as well as at the form itself? Is not the possibility of accurate description greatly increased thereby, and does not the description when made carry more of the desired meaning than ordinary geographical narration, in which there is no definite standard recognized for comparison? The reason of this is not far to seek. Our conception of the unknown is based on the conception of the known, either by likeness or contrast. Ordinary geographic description has not sufficient accuracy, because its terms are vague; they do not bring up to the mind the recollection of any well-defined type or standard. Plain, rolling country, hilly country, broken country, have no precise meaning; they "denote" but do not "connote." But when we examine a series of geographic forms related by community of

structure, though contrasted in age, and give to every one a name, such as a young plain, a mature or middle-aged plain, these terms bring certain well-marked conceptions before us, conceptions that have been elaborated in our study of the type or standard of reference, and we readily form a mental picture in which all the many essential features of the region described are clearly appreciated. An adolescent plain, for example, is a surface of broad even uplands, here and there trenched across by streams which follow valleys of moderate width; the general continuity of level from one inter-stream surface to another comes to mind; the relative scarcity of the smaller stream channels; the relation of the region to its fellows of greater or less age.

It is immaterial what names are used for the present in describing plains and plateaus, for none as yet are authoritatively accepted by geographers, but it would be to our common advantage if experiment were made on the use of a larger set of terms than is now commonly employed. The important point is that terms based on natural relationship should be used, and that they should be familiarized by the study of type forms. Experiment will alone decide what term shall be finally adopted. My own experience with students of undergraduate age has shown me that the idea as here outlined is a valuable one, and that the terms here employed are suggestive and satisfactory. I am very desirous of hearing the experience of others in the same experimental line.

A few words may be said as to the method of using the models, a method that seems to me adapted to young as well as to more advanced scholars. A series of models is laid out on the tables of a room which, in the schools of the future, may, I trust, be called the geographic laboratory. The students are seated near them, and each one is asked to describe what he sees; to note if he can recognize any features of the miniature landscape that are already familiar to him from his own observation. He is then told to try to draw a map of the surface represented, or a part of it if the whole is somewhat complicated. More or less aid must be give here, as so many students are untrained in the simplest delineation. When the map is drawn, show the

class a map of some actual region of the same kind as that typified in the model; ask them to notice how far the features that they have drawn from the model are features on the actual map; let them search for additional features, generally small ones that may appear on the map, but which are not shown on the model.

Next produce the second model, and go through the same process, but without any suggestion that the first and second models are related. Finally, ask if any one perceives a connection or relation between the two regions thus considered. Few can fail to see it, and when perceived it should be described by every member of the class for himself. I have great faith in the scholar's own careful expression, both in drawing and in writing, of what he has himself seen or thought. Note here that the scholar need not discover how the change from one form to the next has been produced, he need only recognize it; then the teacher may supplement the recognition as far as he wishes with simple geological explanation of processes. This need not go far, and merely opens the way to further study of geology. The word geology need not be mentioned.

If the class be somewhat mature, the teacher may, before bringing out the third model, ask for predictions of the form of the future stages of the region; or, if this seem venturesome, the simpler inductive method may be still followed. At last the models showing complications and interruptions in a single cycle of change may be introduced, all the examples being illustrated by maps of actual relations, as well as by models, views, descriptions, and in every other way that the ingenuity of the teacher devises.

When thus familiarized with the general conception of geographic change, let the scholars attempt to make full statement of all they have learned from the work so far concerning geographical relationships. The brighter ones will here manifest some perception of the generalizations that may be based on the facts thus far presented, and from this time on geographic form has a new and a fuller meaning to them. Additional examples of the various stages of development may be introduced at the discretion of the teacher; and if time allow they can be best taken from books

of travel and exploration, reports of state and government surveys, and the like, in order to give some freshness and reality to the study. It is apparent enough that, in its fully expanded form, it will take a long time for the better geographical teaching to enter the larger public schools, but in schools where teachers are numerous enough to give every scholar a good share of personal attention, I do not despair of seeing geographical laboratories and a rational inductive method of instruction employed.

Comparisons have already been made between the methods employed in teaching biology some forty or fifty years ago and during the last decade. It seems to me that physical geography is still in the undeveloped condition that biology has outgrown. Our text-books of physical geography attempt to describe the whole earth, just as the old natural histories tried to describe the whole animal and vegetable kingdoms. Since the publication of Huxley and Martin's Biology, this plan has been abandoned in the better schools, and the pupil now studies the few typical forms that give him a knowledge of the great resemblances of animals, and does not dwell on their minute differences. He learns a good deal about a few animals instead of a very little about a great many. I should like to see the same change introduced into the teaching of physical geography. It is impossible for a scholar to learn anything definite about the form of the earth's surface if he attempts to study all the continents. He might as well attempt to learn about the distribution of forests instead of studying the structure of plants in his botany lessons. Something of the grosser continental forms should of course be considered, just as it is interesting to know something of the distribution of forested and of desert region; the general distribution of land and water, its relation to climate, history, and so on,—all this is of great interest; so are the generalizations concerning evolution and the speculations concerning migrations in which the biologist may indulge, but they do not form the chief matter of our best elementary methods, for they cannot be sufficiently original with the ordinary student. When a boy grows up and travels over the country, he never sees the grosser continental forms; they are too large. He sees only small forms, corresponding to the indi-

vidual plants of the forest. Why not then instruct him in such a way that he shall appreciate these small forms, these geographic individuals, just as he is taught to understand something of botanical individuals? Let him understand that there is a geographic morphology, perhaps not so precise as that of the organic world, but none the less interesting; let him feel that these geographic forms are the results of definite orderly processes, working systematically, and carrying the geographic individual through a determinate sequence of changes, nearly as definite as that passed through by any animal or plant in its life-development, but more complicated from the combination of the records of several cycles of life often being found in one individual. Let him learn that every feature of a geographical individual is significant and expressive, full of meaning to those who look at it aright. Do not hesitate to call on geologic processes when they are needed to aid his understanding; do not postpone the few necessary and simple geological conceptions until he reaches a geological course of study. Do not be discouraged because the earth's surface contains many complicated individuals; there are many simple ones also, which a student may appreciate and enjoy, and from which, when thus understood, he may form a juster idea of unseen regions. Of course there are many complicated forms that he will not easily comprehend; but so there are plants of difficult analysis, yet this is not held to be an excuse for giving up the teaching of systematic botany. Few scholars may be able to analyze all the compositæ, or to recognize all the species of oaks, even if they have learned their lessons well in school, and yet we do not doubt that there is profit in the teaching of systematic botany. So there may be in teaching the elements of systematic geography. Let the scholar learn a few simple forms well, as he surely can without difficulty; he will recognize these when he sees them, and, finding meaning in their form, he will be convinced that there is meaning also in the more complicated forms that his slight study has not deciphered. He may even come to conceive that he has not "finished" geography, and that it is capable of advanced study for its own sake.

Cambridge, Mass., February, 1889.

A NEW CATTLE-PEST.

BY S. W. WILLISTON.

ON October 5, 1887, I received from Professor Cope specimens of a fly taken from the cattle of Mr. Thomas Sharpless, of West Chester, Pa., with the information, shortly afterwards, that the flies had been observed during the year at that place in small swarms, resting on the horns of the cattle, near the base, when not feeding, having the appearance, at a short distance, of small patches of foreign matter. The horns were merely a resting-place, to which the flies quickly returned when disturbed or driven away, the individual flies feeding upon the blood of the animals, concealed in the hair along the flanks. The flies, I was also told, were observed the same year on the land of Mr. George Pim, of Marshallton, Chester county.

I am thus particular in giving the facts as told to me, for this is the first record, of which I am aware, of the introduction from Europe of a cattle pest that bids fair to extend itself over the whole United States, and be as troublesome as its nearly related pest, the well-known stable-fly, or cattle-fly, also European originally, *Stomoxys calcitrans*, Linn.

I had never seen or heard of the fly before, and for that reason immediately reached the conclusion that it was an introduced species. A careful search of the literature, however, gave but slight clue to its identity, though it was immediately seen to be a member of the genus *Hæmatobia*, which, by Schiner, was looked upon as forming a division of the genus *Stomoxys*. In the early spring of the following year specimens of the same fly were sent me by Professor Riley, from, I believe, somewhere in New York and New Jersey, and more recently Mr. Howard reports it from Delaware and Virginia. Not knowing what else to call the insect, I gave it the provisional name *H. cornicola*. The examination, for the first time the past spring, of male specimens, sent me by Mr. Howard, led me to suspect that the species was identical with *H. serrata* Robineau Desvoidy, from the south of France, and in a late number of Entomologica Americana the fly was de-

scribed under the name of *cornicola*, as a doubtful synonym of *serrata*. Since the publication I have learned that the fly had been positively identified as *H. serrata* for Prof. Lintner by Mr. Kowarz, of Bohemia, whose authority on the subject is the best. The fly will thus be known as *Hæmatobia serrata* Rob. Desv., and in the vernacular the name used by Mr. Howard, in "Insect Life," of Horn-fly, seems the most appropriate.

So much for a brief history of the actual and probable pest in our own country, and this history, brief as it is, seems fuller than that of it in its own home, for I can find but very little in reference to it. Desvoidy described it in 1830, and Macquart gave an equally brief description of it in 1838. Rondani separated the species into another genus, which he called *Lyperosia*, in 1856, and Robineau Desvoidy, about the same time, gave it the name *Priophora*. It may be that these names will obtain acceptance, one or the other (for they are not synonymous), for these species, but the characters are based upon minute differences of the bristle of the antennæ or a secondary sexual character, and the time is not yet when we may accept them. It is much to be desired that the name of a common pest may remain unchanged, but so long as we know so little of its allies it is impossible to preclude change in the nomenclature.

The fly belongs to the family Muscidæ, and in the group Stomoxyinæ, which some excellent entomologists deem equivalent in rank to the Muscidæ (or Muscinæ). It will be distinguished from the common cattle-fly by its smaller size, and more especially by its long palpi, and has for its immediate allies some of the most vexatious of flies indigenous to Europe, Asia, Africa, Australia, North and South America. Two of these are well-known to all, either by repute or experience,—the cattle-fly and the tsetse-fly. *Stomoxys calcitrans* was doubtless originally European, but its spread has been almost coëxtensive and cotemporaneous with man. In the United States it reaches from the Atlantic to the Pacific, a torment to both domestic and wild animals, and I have seen specimens from Rio de Janeiro. The tsetse-fly, (*Glossina*, of Africa), of which several species are known, has been, perhaps, the most famous of all for its poison-

ous effects upon horses and dogs, though only annoying to man. Very recently another species of the tsetse-fly has been discovered in Australia, with similar "poisonous and pestilential" habits. A genus allied to *Stomoxys* is ascribed to South America, though I know nothing further concerning it.

Among the diptera we have a number of families of widely different structure and habits that subsist, either wholly or in part, upon the blood of mammals, including the mosquitoes (Culicidæ), with about one hundred and fifty known species, scattered over a large part of the world, the Simuliidæ, with the Buffalo gnat, and about sixty other widely-distributed species, the horse-flies (Tabanidæ), with over thirteen hundred known species, the score or two of species of Stomoxyinæ, and a few species of Chironomidæ and Leptidæ. In all these flies it is the female only that draws blood, and they all seem to have the ability to emit a poisonous saliva into the wound they make, in some of a more irritating nature than others. The males, in general, are harmless, lounging fellows, with a proboscis weaker than in the female, used in sipping nectar from flowers, or the sweet sap of plants. They are not so commonly found as the females, and of the tsetse-fly are still unknown. *Hæmatobia serrata* has habits very similar to those of *Stomoxys*, as stated in Insect Life. The eggs are deposited in fresh cow manure, and only twelve days are required for the insect to acquire its adult condition. What its future in America will be one cannot say; there can be but little doubt, however, that it will soon spread over the entire United States.

It is very probable that the largest number of cosmopolitan insects are found among the Diptera. Reasons therefor we can readily find; they furnish the greater number of our domestic pests, and their eggs or larvæ are constantly mingled with our food material, or common objects of commerce. Indeed, the wonder is not that there are so many species that follow man in his colonizations and migrations, but that the number is so few. *Musca domestica*, that inseparable companion of man, is believed to occur everywhere about his dwellings; even on the uninhabited plains of America it abounds, as Professor Snow has

observed, and as I can corroborate. Rather interestingly, too, like other domestic animals, it seems subject to modifications of climate and environment to such an extent that several varieties have been described from the different countries it inhabits. Almost equally widely distributed are the other plagues of the housewife,—the blue-bottles, *Calliphora vomitoria*, *C. erythrocephala*, *Lucilia cæsar*, and *L. cornicina*,—all of which have distributed themselves from Europe throughout the length and breadth of North America, and some even into South America.[1] In fact, little as we know about the Muscinæ of our country, nearly a score of species are known to be identical with European ones.

But we have no right to say that all such species are importations; some, perhaps many, of them undoubtedly are, but assuredly not all of them are. And even those whose original habitats have been extended through commerce, we may as rightly believe to have been *exported*, in many instances, as *imported*. Commerce with America far antedates the systematic or even superficial study of insects, and the dissemination of insects would as likely be to as from Europe. The Colorado beetle is a striking instance coming within our own observation. The Hessian fly is another that stands almost on the border line of history, and though, as Professor Riley shows, we have every reason to believe that it was originally an European insect, yet had reliable evidences of its occurrence in North America extended back a few years earlier we should never have known whether we had Europe to thank for the pest, or Europe us, as she has more recently for the phylloxera and grape-vine fungus, or whether, indeed, there should be no exchange of thanks at all, the insects being "at home" in both continents. The screw-worm fly, *Lucillia macellaria*, occurs from Canada to Patagonia; will it become naturalized in Europe?

The distribution of many species in both Europe and North America opens up a number of interesting questions about which

[1] *Calliphora vomitoria* has been accredited to South America, but in the examination of considerable material from Brazil I have not found either of the Luciliæ, though a closely allied South American species appears to take their place.

opinions will differ. Doubtless other orders have many such cases, but my studies enable me to speak of the two-winged flies only. In but a very few families of flies, in reality I may say in but one or two, do we have even a tolerable knowledge of the North American fauna. In quite a number, however, our knowledge is sufficient to base fairly good conclusions as regards distribution, and these conclusions lead me to the belief that almost invariably species of flies common to the two continents have an unusually wide distribution in this country. Ten per cent. of our species of Syrphidæ, a family of flies that comes rarely into direct relation with man's economy, are common to the two continents. Of the thirty species thus known very nearly all are found from the Atlantic to the Pacific, forming very nearly a half of the species that are known to occur across the United States. In the family of Tabanidæ, or horse-flies, not a single one of the hundred and fifty species is known to be common to the two continents, and very few species in the United States have a wide distribution. Among the Asilidæ, a large family of predaceous flies, one species, and one only, is known to extend into the two continents, and this one species is one of the four or five that are found on the Pacific and Atlantic coasts. In numerous other cases I have observed similar facts, and always confidently expect to find such species reappearing in the Western fauna. What conclusions may we draw from such facts? That their distribution has been due to commerce? Or, that they are indigenous throughout their extended habitats, persistent forms that have survived unchanged from preglacial times? Among the desmids, out of about three hundred species accredited to the United States, only about one-third are said to be peculiar to our fauna, the others common to all parts of the world, though chiefly European. As among other insects, I have found species of flies occurring only in the White Mountains and the Pacific fauna, which indicates the persistency of their types from different geological and climatic conditions. The circumpolar habitat of many such species may, as Osten Sacken suggests, account for their occurrence on the two sides of the continent, as well as in Europe, but it is purely gratuitous to say

that it will account for all, and the notable case brought forward by the same author of *Catabomba pyrastri* is a pertinent one. This European species occurs in abundance in the western United States and in Chili, but has never been found east of the Missouri river. So, too, I doubt not that the European *Eristalis tenax* was at home, at least for awhile, on the Pacific coast before it suddenly spread eastward about 1870.

On the other hand many species that we should naturally expect to find on the two continents are yet confined to the one. Some, if not many, of these have failed to migrate simply because a good opportunity has never occurred, and our *Hæmatobia* is evidently of this class. But for others other explanations must be sought for. As the black rat and the Norway will not abound in the same region, so it is not unreasonable to suppose that the incompatibility, if one may so put it, of many species will prevent their living in common. Again, too, possibly the numerous parasites of insects may find an adaptabilty to newly introduced forms that may not only keep them in check, but actually keep them from obtaining a foothold. More potent causes undoubtedly are the climatic conditions and food supplies. As before intimated, those families of flies having the widest range of distribution for their species have generally the largest number of "foreign" species, while those in which the habitats are restricted have but few such species. A possible explanation for the latter is that a greater struggle for existence has weeded out the poorly favored ones and adapted the remainder more closely to the immediate environments. Certain it is that many of those families that are confessedly difficult to the systematist are the ones having fewer "foreign" species.

However, the very extensive family of parasitic Tachinidæ have remarkably extended habitats for their species, while I do not recall a single species common to the two continents, though a number reach through the two Americas. This non-identity of forms may be more apparent than real, yet it is very singular that none have been recognized, while in the related family of Anthomyidæ nearly a third of the recognizable hundred or so species are "European," and the family has, if anything, been

less studied than the Tachinidæ. Professor Riley has proposed the feasibility of introducing the European Tachinid parasite of the asparagus beetle, but my opinion is that such an attempt would fail, though it would certainly be very interesting. The difficulty in the way of the insect host may be the cause of such non-importation, but it hardly seems so, for many species are parasitic upon numerous forms, and American parasites allied to the European ones have, in not a few instances, adapted themselves to European insects that have been introduced into, or at least occur in, this country.

In the parasitic family of bot-flies it is probable that all the species common to the two countries (eight) have been introduced with the domestic animals, with the exception of the circumpolar reindeer bot-fly. They all occur from the Atlantic to the Pacific,—that is, those of the United States,—and not a single species of their respective genera (leaving out the doubtful case of *Hypoderma bonassi*) is indigeneous. In the genera *Cuterebra* and *Cephenomyia* not a single species is known to occur outside of North America. Among the mosquitoes three or four species, from among about forty, are recorded as common to the two continents.

New Haven, Conn.

EXPLANATION OF PLATE.

FIG. 1. *Hæmatobia serrata* R. Desv., female.
FIG. 2. Head of male.
FIG. 3. Head of female.
FIG. 4. Hind foot of male.

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PLATE XXX.

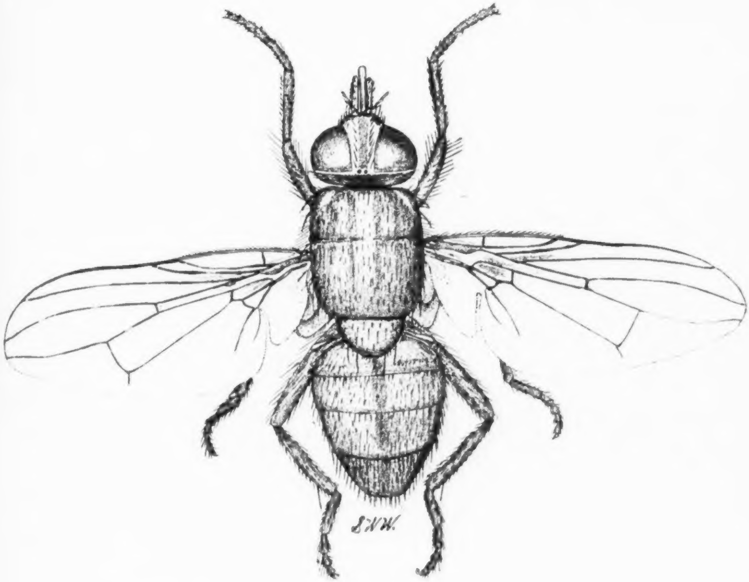

FIG. 1.

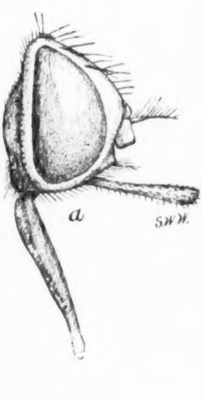

FIG. 2.

FIG. 4.

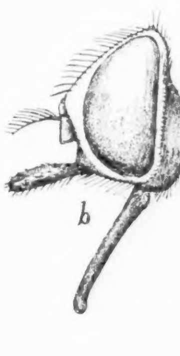

FIG. 3.

ON A FEW CALIFORNIAN MEDUSÆ.

BY J. WALTER FEWKES.

VERY little is known of the different genera and species of Medusæ which live in the waters contiguous to the coast of Southern California. There is every reason to believe that this fauna is very rich, and extremely interesting and instructive so far as its geographical distribution is concerned. The animals of this group from the west coast are represented by genera and species widely different from those found on the Atlantic seaboard. The coast of California, washed as it is by the largest ocean of the globe, is bathed by great oceanic currents, bringing with them their quota of oceanic and pelagic life. We should naturally expect there forms of medusan life of strange appearance to one who has always studied similar animals from the Atlantic.

A few attempts have been made to use the dip-net in the Pacific coast, but we cannot say that more than a beginning has been made, and it may rightly be concluded that an abundant harvest awaits the collector of pelagic animals who first carries on continued work in these waters.

In the present paper I have attempted to consider a few representatives of the group of Medusæ which were captured in a trip across Santa Barbara Channel in the spring of 1887. No accounts[1] of several of these Medusæ have ever been published, although some of them are very different from those which are found in the waters of the Atlantic. Our work on these animals may serve as an introduction, or to call attention, to a line of

[1] I refer simply to the floating medusan life, not to the fixed hydroids. There are several elaborate papers on the Hydroidea of the coast of California, which give a very good idea of the general facies of this group from this locality. This paper deals only with the floating Medusæ, and only makes casual mention of one or wo fixed hydroids, of which little or nothing is known.

investigation which is destined to reveal a rich harvest to any one who may take up the study of these facinating animals. There is no subject which would more richly repay observation than that of the Medusæ of California. I have here pointed out the most important general structural features of these genera, and have introduced a few comparisons with similar genera from the Atlantic, with which students of zoölogy are more familiar.

Of the group called Acraspeda, or Discophorous Medusæ, a species of Pelagia is one of the largest and most striking of those which make their way into the Santa Barbara Channel. Compared with the Pelagia of the Atlantic and Mediterranean Sea, *Pelagia noctiluca*, the Pacific Ocean representative, *P. panopyra*, is a veritable giant. Specimens were captured which had the "tentacles" of the mouth over four feet in length, and the dimensions of the body in proportion. The Atlantic Ocean Pelagia is commonly not more than a fifth of the size of this form.

The first figure gives a representation of the general form of this Pelagia as it was observed floating near the surface of the water in mid-channel. The umbrella, which forms the upper portion or body, is over two feet in diameter, and from the center of the under side there hang down four long, frilled, flexible tentacles, which form the lips of the mouth, or oral aperture. There are eight "sense-bodies" arranged at regular intervals around the margin of the umbrella, alternately with which arise the tentacles, or the long, thread-like structures conspicuously shown in the figure. This Medusa, from its very large size, is one of the most striking, and seems to be common at certain seasons of the year, according to reports given to me by the fishermen, but I was able to collect only a half dozen good specimens. The examples captured had a beautiful pink color, which was especially brilliant on the tentacles and exterior of the umbrella.

The genus of Acraspeda called Aurelia, represented on the Atlantic coast by the well-known *A. flavidula*, is also found in the Pacific, and is represented on the coast of California

5-42

PLATE XXII.

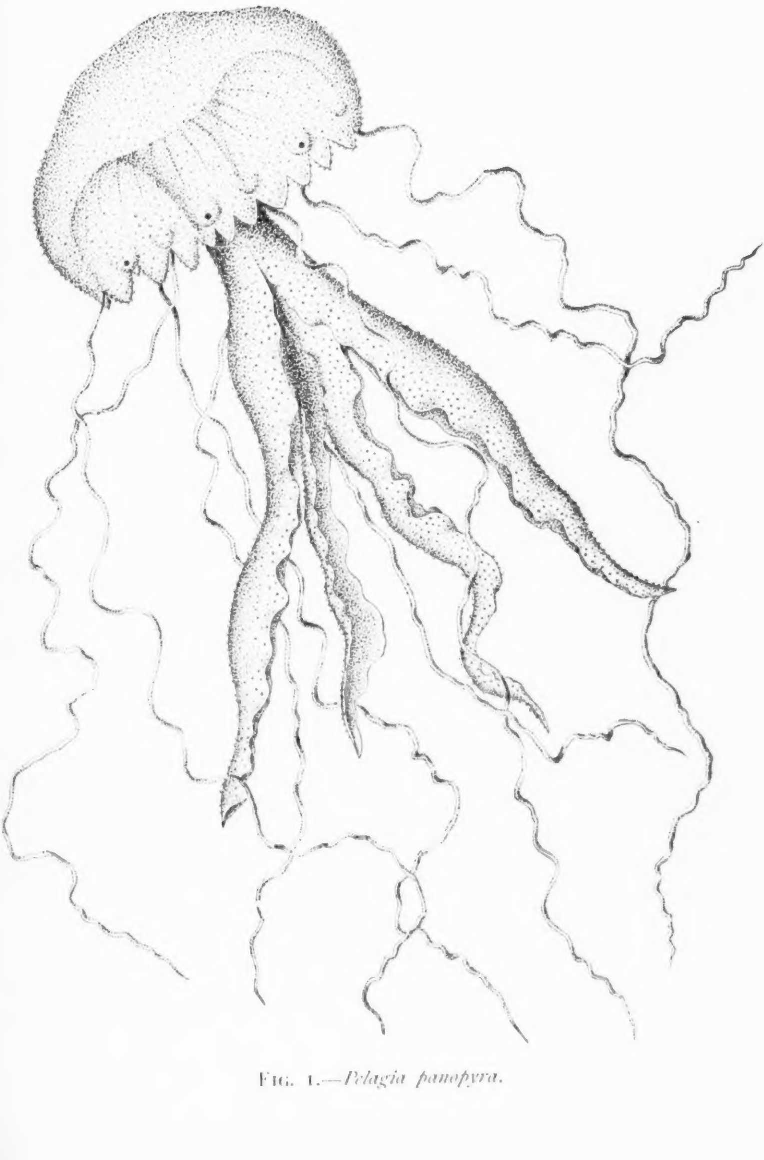

FIG. 1.—*Pelagia panopyra.*

by a beautiful species, *Aurelia labiata.* This species, like the Atlantic, has eight sense-bodies on the bell-margin, between which there are numerous short tentacles as represented in Fig. 2. The color is more pinkish than that of *flavidula*, but the specimens observed are smaller. It was met with but once in my surface fishing in the Santa Barbara Channel, but north of Santa Barbara, at Monterey, it was found several times, and according to trustworthy reports this jelly-fish is very common, in certain months of the year, along the west coast of the United States.

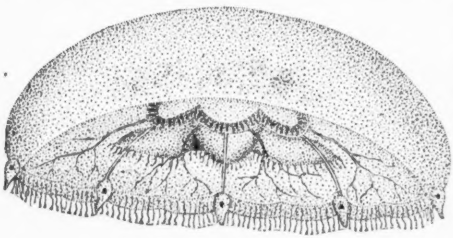

FIG. 2.—*Aurelia labiata.*

One of the most beautiful, conspicuous and abundant jelly-fishes found in the Santa Barbara Channel in the Spring months is a genus Polyorchis, represented by a single species, *Polyorchis penicillata* (A. Ag.) This Medusa is common in all stages of growth, and often swarms in the waters about the landing places. It is easily recognized by the peculiar character of the radial chymiferous tubes, which are four in number, and from their sides there arise lateral branches as shown in the figure. The ovaries hang from the upper portion of the manubrium from a gelatinous elevation or extension of the bell which bears the proboscis. This position of these organs is peculiar, for while Polyorchis belongs to the so-called Tubularian hydroids, in none of which these otocysts are situated on the bell margin, the position of the sexual bodies is exceptional. In the majority of the Tubularian or Anthomedusan hydroids the sexual bodies arise from the proboscis itself, but here these bodies hang from a gelatinous extension of the bell, or, more exactly, form the radial tubes which cross this prominence. Practically, therefore, we have here a Medusa which has characters of hydroids like Sarsia and those like Oceania, representatives of two groups, for while

otocysts are wanting on the bell margin, as in Anthomedusæ, the sexual bodies hang from the radial tubes on the bell as in Leptomedusæ or Oceania-like genera. In most respects, save the simple position of the sexual bodies, Polyorchis is however a true Tubularian.

The youngest form of Polyorchis which was found betrays clearly the affinities of the adult, since it shows that the side branches from the radial tubes are in reality structures of comparatively later growth in the development of the Medusa. The accompanying figure represents an undeveloped or young individual of Polyorchis before the side branches of the tubes had formed, and before the tentacles had reached any considerable length. Like the younger forms of many young Medusæ of widely different genera we find clusters of small bodies superficially resembling nematocysts strewn over the external surface of the bell. The immature Medusa has no apical prominence on its bell, and in general its umbrella is more elongated, with a longer vertical diameter, than the adult. All stages of growth between the young represented in Fig. 4 and the adult can be easily collected.

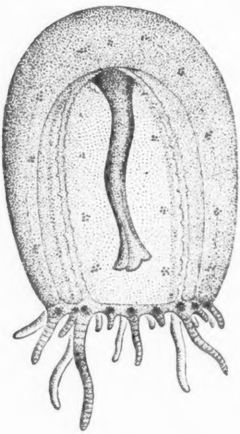

FIG. 4.
YOUNG POLYORCHIS.

There is another very curious Medusa likewise belonging to the Anthomedusæ, which is found in the vicinity of the Island of Santa Cruz.[1] This Medusa is so remarkable that a figure of it is introduced for comparison with related representatives from the Atlantic coast.

One of the most interesting genera of Tubularian Medusæ

[1] The island of Santa Cruz is the nearest of the Santa Barbara islands to the city of the same name.

PLATE XXIII.

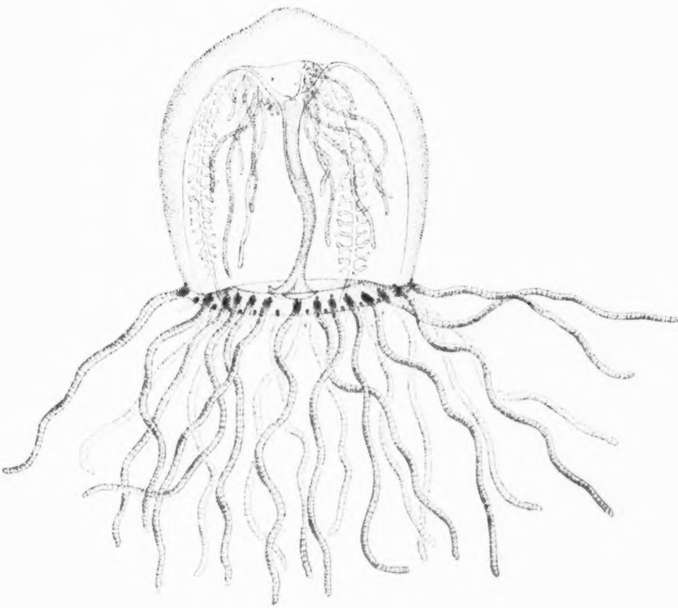

FIG. 3.—*Polyorchis penicillata.*

found in the waters of the Atlantic is a strange genus called Dipurena. This jelly-fish is remarkable from the fact that while its bell resembles closely that of Sarsia, the Medusa of Syncoryne, the form of the tentacles is very different. While Sarsia has long, highly-flexible tentacles, Dipurena has, in the same position, arranged at regular intervals on the bell, nine stiff club-shaped appendages, enlarged at their tips into clavate organs of unknown function.[1] The form of the bell, the structure of the tentacles and the proboscis of Dipurena have been figured in my paper on the "Jelly-fishes of Narragansett Bay," to which the reader is referred for a knowledge of the peculiarities of this most interesting animal. The points with which we have at present to deal are the following: Dipurena has a hemispherical bell, four simple radial chymiferous tubes, and four stiff tentacles which are enlarged at their extremities into club-shaped bodies resembling small dumb-bells. The length of the proboscis is very much longer than the height of the bell cavity, and through its walls the ova can sometimes be seen in packets occupying two regions. The mouth is simple, resembling that of Sarsia, and at the base of the stiff tentacles on the bell margin there are simple pigment spots or ocelli. Dipurena is rare on the coast of New England, but it seems to be more common in the Gulf Stream, and occurs in numbers in Floridan waters and on the Carolina coast.

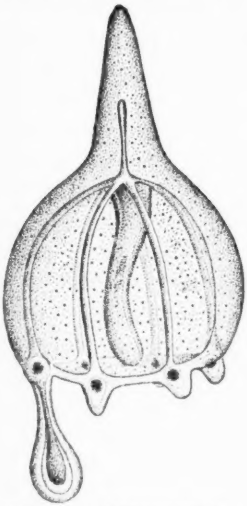

FIG. 5.—MICROCAMPANA.

Under the lofty cliffs of the island of Santa Cruz, opposite Santa Barbara, a Medusa with certain of the characters of Dipurena was taken in the Spring of 1887. There are features of this Medusa which stamp it as a most characteristic one, and

[1] It seems highly improbable that the function of these clavate appendages is the same as that of the long flexible appendages or tentacles of Sarsia.

as highly exceptional, differing from any which has yet been described. I suggest for it the name Microcampana, the structure of which is indicated below. Microcampana has *six* radial chymiferous tubes instead of four, eight or a larger number, as ordinarily occurs among its nearest allies.

Among Hydromedusæ the majority of genera have four radial tubes, but there are several, as Melicertum, which have eight, and still others, Zygodactyla, which have more than eight. Four, however, is the normal number in the majority of genera, and there are only two or three which have six. Microcampana is therefore in the first place exceptional in the number of radial tubes. It has, moreover, a single club-shaped tentacle, resembling, it is true, that of Steenstrupia in the fact that it is single, but closely allied to those of Dipurena in anatomical characters. It is the only known genus which approaches Dipurena in the peculiar form of the tentacles. Unlike the last-mentioned genus, the apex of the bell is prolonged into a conical projection, through the middle of which, at least in its basal region, passes a small tube, the homologue of which is found in several genera where it is often the remnant of a former connection with the hydroid from which the Medusa has been formed by gemmation. The conical projection at the apex of the bell is exactly reproduced in two Atlantic genera, Stomatoca and Dinematella, neither of which, however, has less than two tentacles. To recapitulate, then, we have these extraordinary features in Microcampana, which are found in combination in none of the known Hydromedusæ which have yet been described: there are *six radial chymiferous tubes, a single tentacle, which is inflexible, and enlarged at its tip into a dumb-bell-shaped structure,* and an apical projection on the bell penetrated by a median canal originating from the common junction of the four radial tubes, and terminating blindly in the substance of the projection.

It is probable that the size of this Medusa (it is barely an eighth of an inch in diameter), and the existence of but a single tentacle, are indications of immaturity. It may later be found that other tentacles are developed, and new affinities be sought for it. To this conclusion, the fact that a remnant of what may be a former

PLATE XXIV.

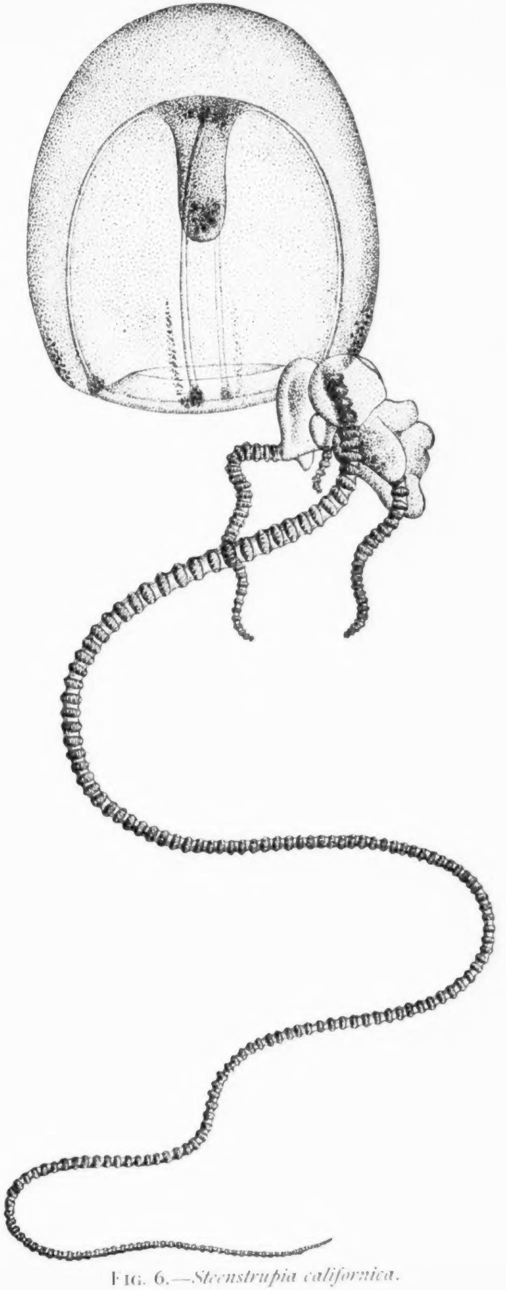

FIG. 6.—*Steenstrupia californica.*

connection with the hydroid, seen in the apical projection, adds some weight. Even if it is an immature Medusa, the character of the tentacles, so like those of Dipurena, is exceptional. The specimen cannot be confounded with Dipurena on account of the greater number of radial tubes.

It may be urged with some weight that we are dealing with an abnormal specimen, and that the extra tube is an abnormality. Granting that such is the case, the apical projection remains as a feature not possessed by any of the species of Dipurena, and ordinarily the apical projection is a late formation on the bell of a Medusa as shown in the development of Stomatoca and Dinematella.

Microcampana is not the only unitentacular Medusa found in the prolific waters of our Pacific coast. A second genus, known from the Atlantic for many years, is also represented in the Santa Barbara Channel.

A bizarre genus of Hydromedusæ, found on the Atlantic coast, is known as Hybocodon, the "hunchback" Medusa. The same, or a very similar, genus from Europe is called Steenstrupia. There genera are remarkable from the fact that they have but one long, flexible tentacle. One of the most interesting features of this Medusa is that the young arise as buds from near the attachment of this tentacle to the bell margin. It is a true Tubularian, with the peculiarities of that group, but has three of the tentacles so reduced as to be wholly wanting, while the fourth is very much prolonged and is highly flexible, armed with ferules of powerful "stinging cells,"—nematocysts. The young, with the bells in process of formation, each with its own tentacle more or less completely developed, and clustered at the base of the long tentacle of the parent, can be seen in my figure. When sufficiently developed these budding individuals probably break their connection with the mother, and from the bases of their tentacles in turn they develop new broods.

Among the many other Hydromedusæ which live in the Californian waters, one of the most beautiful is closely allied to Sarsia, a genus abundant at times in Massachusetts Bay. This beautiful animal has received the name *Sarsia rosaria*, and is the

free gonophore of a form of hydroid called Syncoryne. The simple structure of this Sarsia can be seen in the two cuts, the smaller of which represents the young, the larger the adult form of the same jelly-fish. They were found very abundant near Monterey and Santa Cruz, and several specimens were taken from the Santa Barbara Channel, where, however, they were not found as abundantly as in the former locality. The species is readily distinguished from the Atlantic representative by its greater size and by the color, while the proboscis is much shorter than that of *Sarsia mirabilis*, so abundant at times on the coast of New England.[1] As is well known, the Anthomedusan and Leptomedusan groups of Hydromedusæ are supposed to arise as buds from fixed hydroids, excepting perhaps the somewhat doubtful case of the Lizzia recorded from Scotland, of Claparede. In genera where we have young Medusæ budding from Medusæ among these groups, as in Lizzia, Sarsia, and others, it is not impossible that a direct development in which no fixed stage is found, direct development not unlike that of Cunina, may exist, but such a form of development has yet to be described. The genus Sarsia has a development of young by the budding of new individuals from the proboscis of the parent *S. prolifera*, and from a fixed hydroid Syncoryne.

The piles of the wharf at Santa Barbara are peopled by a beautiful pale pink hydroid, belonging to the genus Syncoryne, which may possibly be the hydroid of the Sarsia just described. These hydroids are found in clusters with a common basal connection, each head rising from a single stem as shown in the figure given here. On a single magnified head we detect the club-shaped tentacles and the ovate "buds," which are Medusæ in all stages of

FIG. 8.—CLUSTER OF SYNCORYNE HYDROIDS.

[1] The hydroid Acaulis, found at Grand Manan and Eastport, Maine, is a most interesting genus of free hydroids with Medusa buds. This genus, which might be mistaken for the head of a Monocaulis, is probably an interesting connecting link between the Siphonophora and the fixed hydroid or its homologue the budding Cunina.

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PLATE XXV.

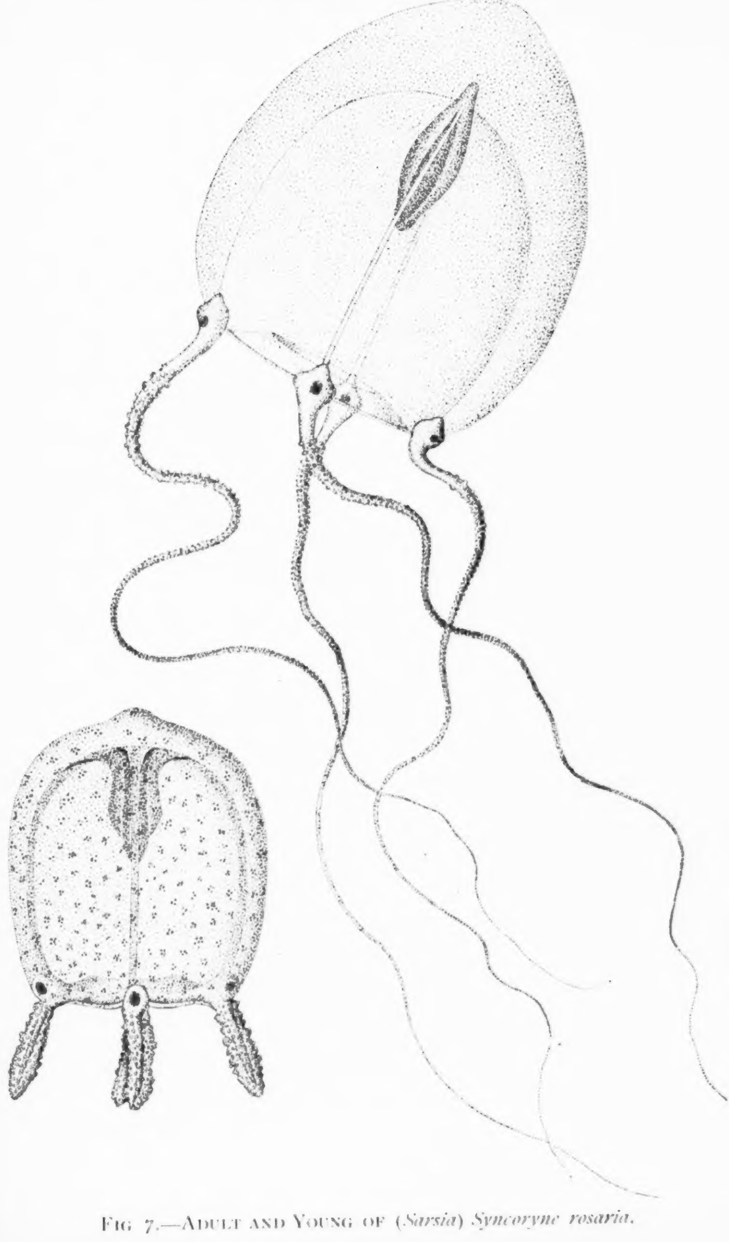

FIG 7.—ADULT AND YOUNG OF (*Sarsia*) *Syncoryne rosaria.*

development. I have not been able to trace these "buds" into

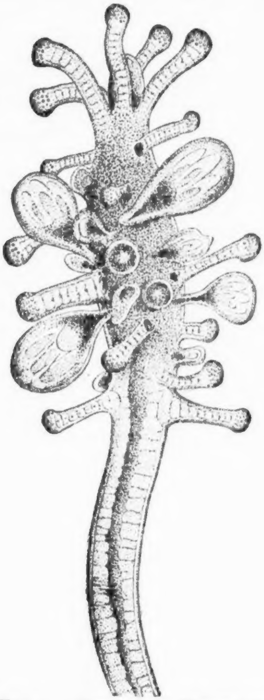

FIG. 9.—ENLARGED HEAD OF A SINGLE SYNCORYNE.

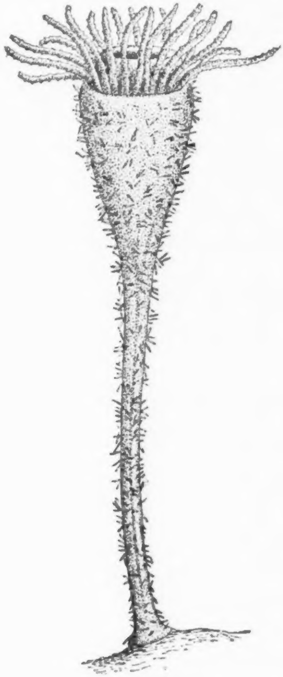

FIG. 10*a*.

a young Sarsia, but from what is known of the hydroid of the Atlantic Sarsia, it seems highly probable that this hydroid is the young of the Pacific Coast Sarsia.

FIG. 10.

Associated with the preceding hydroid on the piles of the wharf at Santa Barbara, there is another hydroid not yet determined, figures of which are given herewith. These hydroids belong to the second group of Hydroidea, or the Campanularians, and are found in clusters, as shown in the first figure. The larger cut represents a single head, very much magnified, with the tentacles

partially retracted. Along the sides of the body clusters of unicellular algæ are seen, which sometimes occur in such numbers as to almost completely conceal the body of the hydroid.

There is another curious Hydromedusa, which was taken in the skimming nets used in pelagic fishing in the Santa Barbara Channel. The genus Willia is remarkable for the bifurcation of the radial chymiferous tubes, as shown in the cut.

This interesting genus, never before recorded from the waters of California, is related to the young of a genus Proboscidactyla, and the Medusa figured may belong to this genus.

One of the most interesting Medusæ from the Santa Barbara Channel is a little-known genus, Athorybia. Athorybia is a member of the group of Siphonophora known as the Physophoræ, although it bears little superficial likeness to Agalma and Physalia, two of the best-known members of the group.

The anatomy of Athorybia is simple. The most prominent structure is an oval float of pink color, from which there hangs a tube-like or trumpet-shaped body, as represented in my figure. At the base of the float there arises a circle of leaf-like bodies, transparent, gelatinous, penetrated from end to end by a tube, and crossed in their exterior by motor lines of lasso-cells. Very flexible bright pink bodies called tasters hang out from beneath the flat leaves, or, as they are called, the covering-scales, and long, highly flexible tentacles extend far beyond the tips of these and other organs of the body. Each tentacle bears a tentacular knot, as it is called, which are lateral branches, enlarged at one end, and with the termination divided into three divisions. The main body of the knob at the end of the lateral branches is composed of a spirally-coiled structure, covered by batteries of stinging cells, and partially enclosed in a covering-sac or involucrum, which is extended on one side into a conical projection or apex, as represented on the figure. There is but one kind of these structures along the tentacles of Athorybia, but in the neighboring genus Diplorybia from Florida there are two kinds of these structures.

The interpretation of the function of the organs of Athorybia described above, is in certain respects not difficult. The large

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PLATE XXVI.

FIG. 12.—*Athorybia californica.*

oval body above is a float, the flask-shaped or trumpet-like organ the polypite, whose inner wall serves as a digestive organ, and whose terminal opening is a mouth for the capture of food. The leaf-like covering-scales, sheltering beneath themselves the other organs or zoöids, often keep up a flapping movement, by means of which the Athorybia is propelled from place to place. The function of the tentacles and tentacular knobs is probably the capture and retention of the prey. No sexual bodies were observed, from which we may readily conclude that the specimens which were captured were immature.

One of the most interesting of all the surface animals of the ocean is a beautiful genus called Velella, which receives its name from its fancied resemblance to a "little sail-boat." This genus is often so common in the Mediterranean Sea that the surface of the water appears to be almost covered with them, and after favorable winds they are sometimes accumulated in great masses along the shores and in the small bays and harbors of the Italian coast. In Florida, likewise, a similar animal occurs in great numbers, and stragglers often make their way even to the New England coast, where they are often stranded on our Southern beaches.

A Californian species of Velella, found along the west coast of the United States, occurs in the waters of the Santa Barbara Channel, and although often very abundant, is at times rather rare. Its bright blue color and its strange form make it a noteworthy Medusa.

In the accompanying cut there is shown a view of this Californian Velella, as seen from above, looking down upon it as it floats on the surface of the sea. The diagonal oval region, crossed by a thin triangular plate, the edges of which are seen in the figure, is the float, which is composed of many concentric apartments, each opening exteriorly by a small orifice, and all communicating with each other. The larger oval is the body of the Medusa, and as it floats on the surface of the water this portion, which is flat, forms the great mass of the animal. Through its walls, which are of bluish color, the tentacles can be seen,

but the feeding-polyp, which lies in the centre of the under-side, is hidden by the oval float in the middle of the body.

Of all the Medusæ considered, Velella is the only one which floats on the surface of the sea, the whole upper surface of the body, or that shown in the figure, being exposed to the air. From this fact, as well as from certain rhythmical motions made by Velella, it is not improbable that the respiration is in part aerial in this Medusa, as has been already pointed out by Dr. Carl Chun. To facilitate this mode of respiration, and to bring the air into the interior of the body, there are tubes, called tracheæ, communicating with the cavity of the float, through which air is taken in and gas expelled by the movements of the body. At the same time there is also an abundant opportunity for aerial respiration through those parts of the body which are always exposed to the air.

NOTES ON THE HABITS OF SOME AMBLYSTOMAS.

BY O. P. HAY.

MY observations on the habits of the Amblystomas have been made almost wholly on the three species, *A. microstomum, A. tigrinum, and A. punctatum.* These species have received respectively the vernacular names, small-mouthed salamander, tiger salamander, and spotted salamander. All three are quite abundant about Indianapolis, the *microstomum* most of all; and it is this that I have been enabled to study most carefully. Unless otherwise noted, my remarks will refer to this species. It will be most convenient perhaps to begin with the life of the individual; first of all with those events which make provision for the life of the individual.

The eggs of the small-mouthed salamander are laid very early in the spring, as soon as the thick ice of the winter is gone, or even before it is gone. During the present year I found eggs of this species at noon of March 3. They had probably been laid during the preceding night. They were attached singly

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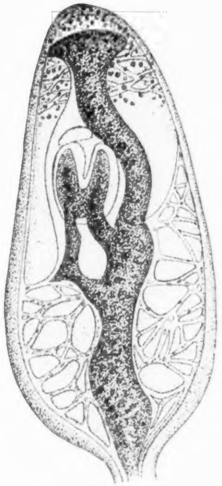
PLATE XXVII.



Gonosac of Atractyloides.

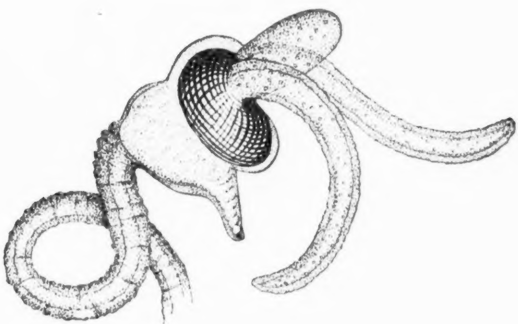


Fig. 12 *a.*—*Athorybia californica.*

and in bunches of various sizes to blades of dead grass and to sticks under water. I have also seen them strung along on the bottoms of shallow ditches, as if they had been deposited by the female while crawling about. I have reason to suspect that eggs had been laid in the same ponds at an earlier date. It is also certain that oviposition continued at least as late as March 22.

The eggs are quite small, the diameter being about 2 mm. Each egg is surrounded with a capsule of a clear gelatinous substance, by which it adheres to other eggs and to objects in the water. This mass of gelatinous matter has a diameter of from 6 to 9 mm. It is made up of two principal layers separated from each other by a very thin layer, and from the yolk by apparently two other very thin layers.

How the eggs are fertilized by the male I have not observed; but it is probably much as in the case of *A. punctatum*. Some eggs strewed by a female over a brick in an aquarium failed to develop, doubtless because they were not fertilized. All the eggs found on the third of March had begun segmentation, and it was not long before the outlines of the embryo became visible. The changes passed through by the embryo cannot be here detailed. Very early cilia are developed on the outer surface, and the embryo begins slowly to revolve within the gelatinous envelope. When it is 8 mm. long it lies coiled within the envelope, and may be seen to possess short buds to represent the gills and the "balancers." About the 28th of March, some of the eggs were so far advanced that on being handled the tadpoles slipped out of the gelatine, and swam about in the water. Already, however, there were more advanced larvæ swimming about in the pond, which I could not distinguish as different. The eggs from which the latter originated may have been laid earlier; but it seems quite certain that some eggs develop more rapidly than others. Many of the eggs which I had more particularly under observation did not hatch until April 10th. At the time of escape from the egg the young are about 10 mm. in length. They are of a bright olive-green color, with indications of squarish blotches along the back. There is a broad fin running along the back and around the end of the tail to the vent. Three

little gills stand out on each side of the neck, and on these may be seen a few rudiments of lateral filaments. The fore-legs exist as the merest little buds. The head is rounded in front, and the mouth is below, features due to the yet persisting cranial flexure. It is doubtful if the mouth is yet perforated. The heart may be seen beating at a lively rate, and the blood coursing through the gills. During the earliest period of its free life, currents of water are directed over the gills and the body by the action of the cilia; but soon currents may be seen to enter by the nostrils and to make their exit through the gill slits. After this the ciliary action becomes feebler, and at length ceases. When the larvæ have attained a length of about 12 mm. [one-half inch] the lateral filaments of the gills have become distinct, and may be seen arranged in two rows on the under side of the main stem. There are four to six filaments in each row. The mouth is now nearly terminal, and microscopic sections reveal the existence of premaxillary, vomerine, dentary, and splenial teeth. Nothing was found in the stomach of this sectioned specimen, but it may have been an unsuccessful hunter. Toward the last of April, the larvæ have reached a length of from 15 to 18 mm. The anterior limbs are conspicuous, and show each two short toes. The posterior limbs are present as elongated processes. The so called "balancers" have shrunken somewhat, and give evidences that they will soon be lost. The tadpoles are more inclined to lie at the bottom of the water when resting than to cling to the sides of the vessel.

From the time of hatching up to this stage the "balancers" are conspicuous organs. They are attached just behind the mouth on each side, and resemble a base ball bat. They are said by Professor S. F. Clark[1] to function as supports for the larvæ when they fall to the bottom of the pond during the period while the fore-legs are still undeveloped. I doubt if they are of much use in this way. In the aquarium they spend much of their time sticking to the walls, and it is by means of these organs that they suspend themselves. They are by no means "suckers," and it is doubtful if they secrete a sticky fluid, as the

[1] Studies from Biolog. Lab. Johns Hopkins University, No. II., 1880.

PLATE XXVIII.

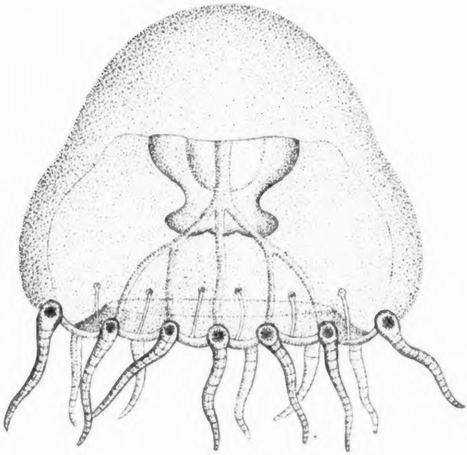


FIG. 11.—WILLIA.

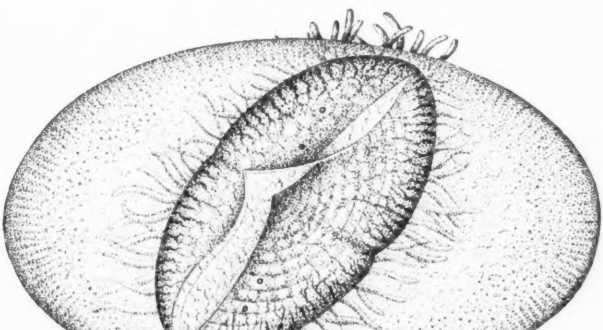


FIG. 13.—*Velella meridionalis.*

organs of adhesion of the frog are said to do. In microscopic sections the epidermal cells near the tip of the organ appear each to project into a point, so that the whole surface is roughened somewhat. Since all objects in the water soon become covered with a thin layer of slime, the holders will adhere to this with sufficient force to suspend a little creature which is of nearly the same specific gravity as the water. When they are put into a clean glass or tin vessel, it is with great difficulty that they can succeed in attaching themselves to the perpendicular side. After making many unsuccessful efforts they sink to the bottom seemingly exhausted, and lie quite as often on their sides as on their bellies. When the holders have been lost, I have observed the larvæ to suspend themselves to the walls by means of their toes, or by a single toe.

While they are adhering to objects by means of the holders one may, under a lens, and with the point of a fine forceps, loose one holder and allow the tadpole to hang by the other alone. One may then touch the forceps to the adhering holder, and succeed in dragging the little animal hither and thither through the water.

Larvæ of the length of 15 mm. had their intestines filled with the remains of small animals. These consisted mostly of entomostracous crustaceans, such as *Daphniidæ*, *Cyclops*, and the like; but there were also found portions of the young of *Crangonyx* and *Asellus*, and of the larva of some beetle. The ponds which harbor these amphibians literally swarm with minute animal life, and the tadpoles are active, hungry, and fierce.

When the tadpoles have become about 25 mm. long, they may occasionally be seen to come to the surface for air. This shows that the lungs are becoming functional. A bubble of air is expelled by the mouth just as, or before, the tadpole reaches the surface; a portion of fresh air is probably inhaled; and the tadpole hastens to the bottom, as if alarmed at having exposed itself.

The changes from this time on until near the time of metamorphosis consist principally in increase in size and further development of the limbs. A tadpole two inches long and full-grown may be briefly described. Those who are familiar with figures

of the axolotl will need little additional description. The body is catfish-shaped. A high membranous fin begins on the back just behind the head, and continues around the tail to the vent. Fore limbs with four fingers each, and hinder limbs with five toes each, are present. On each side of the head are three gills, of which the upper is the longest, and the lowest the shortest. The main stem of each gill bears on its lower edge a fringe of filaments in which the blood is brought into close contact with the water. The upper surfaces of the head and body are olive, mottled and speckled with black; the whole lower surface is white.

Reference has been made to the food of the tadpoles in their native haunts. Last season I obtained a large number of the young of *A. microstomum* and kept them for some time in a glass jar. Soon I found that their gills were disappearing, from which circumstance I concluded that they were transforming. Soon, however, it was also seen that some of them were also losing their legs; whereupon I began to watch proceedings a little more closely. One was seen to seize another by a leg, and a struggle followed for the possession of the member. It was plain that they were devouring one another alive. Not knowing what else to do I procured some slender angle-worms, and breaking them in pieces threw them into the water. Soon a tadpole approched a section of the worm and began to show interest in it. Presently with a sudden leap he seized the morsel and shook it violently, as if he expected resistance. By sudden snaps and gulps the worm was soon worked down the tadpole's throat. A tadpole would in this way swallow a piece of worm of nearly his own diameter and an inch or more in length. After this my specimens were abundantly supplied with this diet, the cannibalism ceased, and the larvæ increased rapidly in size. When they are not supplied with food they are able to endure hunger for a long period, but they do not grow. If one wishes to rear them in aquaria, one may easily strain out the Entomostraca of pond water, and thus furnish them with acceptable food. On the bottom of an aquarium in which a number of freshly-captured nearly-grown larvæ had been kept for a few days, were found numbers of the shells of a small species of *Planorbis* or related genus of mollusks.

Toward the last of May my specimens began to undergo their metamorphosis. The gills began to suffer absorption and the broad tail fin to disappear. They came oftener to the surface for air, and they spent a good deal of their time floating on the water. When the tadpole took in air, he would float horizontally. As the oxygen of the inhaled air was converted into carbonic acid, and this in its turn given off into the surrounding water, the little animal's body grew heavier and he began slowly to sink, the tail going down first. To counteract this a few feeble movements would be made, but still down he would go. At last by a strong effort the animal would bring his head to the surface, take in air, and then quickly regain the horizontal position.

At this time the young showed also a strong inclination to leave the water. They would crawl up on sticks and stones and remain there. When in a glass vessel they would sometimes be found climbing up the perpendicular side, two or three inches above the water.

The time of completing the change is about the first of June, although some specimens may have completed it sooner. As it progresses, the tail becomes more terete and the whole body slenderer and less bulky. The general color above becomes black, while here and there white specks appear; and the animals are soon small models of the full-grown adults.

When my specimens had transformed, about fifty of them were put into a box in which was a sod about a foot square. Into this they immediately disappeared, and burrowed through and through it. When it was allowed to become dry, they would be found under it, where a little moisture remained. When it was thoroughly wet, they would appear at the surface among the grass blades and roots. At length it was allowed to become thoroughly dry, and the salamanders perished. Doubtless, however, many of them had escaped by crawling up the sides of the box.

During the last spring many specimens of the small-mouthed salamander were taken about Irvington, Ind., and several of *A. punctatum*, which latter had not before been seen here. They were taken during March in ponds about which were pieces of fallen timber. On turning over a small log or a rail which lay

partly in and partly out of the water, one or more salamanders could often be found. In such situations they could obtain suitable food, and at night go forth to deposit their eggs. A little later, in the first days of April, they had left these situations, and one could be found only occasionally and away from the water. Later, none of either species could be found anywhere. The summer seems thus to be spent away from the water, burrowing about in the earth. Specimens of *microstomum* kept in the aquarium appeared, as warm weather came on, to be driven by an intense desire to leave the water. Occasionally one would swim about as if frantic; and so many were found dead that they were at length transferred into a box partially filled with earth. In this they remained quiet, at least during the daytime. The Amblystomas seem to be able to endure a good deal of drought, if necessary. A gentleman informed me that he had seen a specimen of the tiger salamander crawling about in a cornfield on a hot day in midsummer. On the other hand, this species seems to be capable of living all summer in the water.

During the winter, no doubt, many of these Amblystomas hide away under sticks and stones, and in the earth away from the water. I believe, however, that most of them betake themselves to the vicinity of the ponds, and remain either close about their borders or in them. I have several times received examples of both *A. microstomum* and *A. tigrinum* that had been taken in January and the early part of February from under the ice of ponds where boys were skating. On one occasion some of these were put into a tank of water; and this having frozen, they remained under the ice two or three days without injury. Some of these same specimens, which species I do not know, laid eggs on January 15.

Early in April of the present year, about thirty specimens of the small-mouthed salamader and eight or ten of the spotted salamander were put into a dry-goods box partly filled with earth. In order to separate the two species, a piece of bagging was tacked across the box. The box stood at least fourteen inches, and the bagging a foot, above the dirt. Every now and then a spotted fellow would be found on the wrong side of the wall.

Fearful lest some of them might escape, wire netting was laid over the box in such a way that it was thought that none could get out. Toward the last of June the dirt was carefully examined, and all of both species but eight specimens were gone. This will illustrate their ability to climb. They rely especially on climbing up the corners. I have watched them climb up the corners of a zinc box six inches high. They brace themselves on each side by pressing their feet against the walls. The tail is also brought into service, but when this was loosened the animal did not fall.

Mention has been made of the food of the older larvæ. The adults of the three species mentioned in this paper feed greedily on earthworms. When a worm is brought near the snout of a salamander, the latter may quietly observe it awhile; or if the worm is crawling away, he may follow it for awhile. Soon, however, there is a sudden forward movement, the jaws open, the broad tongue is protruded; and if the aim has been faulty, the jaws come together with a snap. If the worm has been caught, it is shaken as a dog shakes a snake; the part secured is held fast for awhile; then another quick snap is made and a little more of the worm is taken in. In this way a worm several inches long may be swallowed. It is amusing to watch two large salamanders try to swallow the same worm, one at each end.

It is probable that earthworms furnish the bulk of the diet of the Amblystomas; but they are ready to eat almost anything of an animal nature. A year ago I put a tiger salamander, eight inches long, into a large case with glass sides, where I could watch him. It was occasionally convenient to put other things into the same receptacle; and among them was a full-grown tree-frog, *Hyla versicolor*. Up to this time the salamander had not, so far as I knew, eaten anything for months. A few months afterward the salamander was found holding the frog by the foot, which on examination proved to be somewhat injured. During the day the frog kept out of the way of his persecutor; but next morning it was missing, while the salamander lay in his box of sand blinking serenely, and showing a stomach that protruded like that of the proverbial alderman. A cricket-frog and a large

caterpillar had previously disappeared somewhat mysteriously, and now their fate was explained. I have fed this specimen insects, fresh beef, and tadpoles. Once it swallowed a mass of three or four grape skins; but since he seemed to regard himself as no prodigal son in dire extremities, he refused to accept any more such favors. He swallowed with ease a half-grown wood-frog. A smaller frog had lain about and become dry and stiff. It was offered to the salamander, who began to swallow it but soon rejected it. A freshly-killed mouse was offered him and eagerly seized by the nose. He slowly swallowed it as far as the fore-legs. Then a lack of confidence in himself seemed to seize him, he grew uneasy, dragged the mouse about, and at length succeeded in getting it out of his mouth. The mouse's head was covered with a sticky fluid, the secretion, no doubt, of the numerous glands that fill the tongue of the salamander. Dr. Robert Wiedersheim states that he found a shrew in the stomach of a specimen of *A. tigrinum* that he dissected. One day my large salamander seized a good-sized spotted salamander by the tail, and only with difficulty was he made to release his hold. The amphibians appear to swallow one another without much regard either to relative size or to the ties of consanguinity.

Reptiles at all periods of life, and amphibians after they have lost their gills, have been generally supposed to be wholly air-breathers; unless the skin may take some part in aerating the blood. Recently, however, the Profs. Gage [*Amer. Nat.*, XX., 233] have shown that the soft-shelled turtle enjoys an aquatic pharyngeal respiration, the mouth being filled and emptied by movements of the hyoidean apparatus. More recently [*Science*, VII., 395] they inform us that the newt, *Diemyctylus viridescens*, while under the water, both draws in and expels this element by the mouth. In this process the walls of the mouth and pharynx serve as a place of exchange between the oxygen of the water and the gases of the blood. The same authors have observed water to be taken into the mouth-cavity of *Cryptobranchus alleghaniensis*, and expelled, partly at least, through the gill-slit. This pharyngeal respiration may be readily observed in the three species of Amblystoma under consideration. In all of them, by

the dilation of the hyobranchial apparatus, streams of water are drawn in through the nostrils, and this water is then expelled at intervals by the mouth. By keeping the salamander in a glass vessel containing water that has in it fine floating particles, and using a lens, one may readily see all the phenomena mentioned. The animal will remain under the water several minutes, sometimes a quarter of an hour, breathing in this way. Then will occur motions indicating uneasiness; large bubbles of air may escape from the mouth, and the animal will come to the surface and take in fresh air. It may remain there for some time, or may again go to the bottom and stir about as if trying to conceal itself. The expulsion of the water through the mouth occurs in *microstomum* every eight to twelve seconds; in *tigrinum*, every five or six seconds; and in *punctatum*, every four or five seconds. It is probably due to this pharyngeal respiration that they are able to remain imprisoned for so long under the ice of ponds.

The Amblystomas shed the epidermal layer of the skin at frequent intervals. Whether this occurs oftener when they are in the water than in the earth, I do not know. The large specimen of *A. tigrinum* kept by me seemed to prefer to enter the water when about to exuviate. For some weeks during the past summer while he was confined to the water, he shed his skin about every week. The skin comes off in one almost untorn piece, and floats about in the water like a shadow of the original. It seems never to be swallowed, as it is said to be in the case of the newt.

The popular notion about these animals is that they are very poisonous. On the contrary they are perfectly harmless. Never but once have I succeeded in getting one of these animals even to attempt to bite. Once my large *tigrinum*, thinking that something was being offered him to eat, seized my little finger. His teeth could scarcely be felt. Even if they should penetrate the skin, there is no poison secreted that could enter the blood.

These animals are not averse to being handled. I have thought that the small-mouthed salamander likes to be rubbed along the back with the finger or a straw. When thus rubbed, I have seen it lift its tail high in the air and wave it to and fro in a ludicrous way.

All the tailed salamanders seem to dislike greatly to be turned over on their backs. They struggle violently to regain their normal position. While thus fastidious about being "right side up," some, at least, of the Amblystomas show extremely little intelligence in avoiding falls. They will crawl right off the hand or the table regardless of consequences. Very seldom have I seen my large *tigrinum* hesitate to walk off the surface on which he was resting. Even then had he been touched he would have rushed insanely over. Prof. Samuel Garman has observed that the tail of *A. punctatum* is somewhat prehensile, and is employed to prevent itself from falling. I have observed something of the same kind in this species, but not in the others. It may be permitted to notice here the highly developed prehensile power in the tail of *Diemyctylus.* Its rough flat tail is always ready to catch on objects, if need be. I have kept it hanging for a quarter of an hour on a slender penstock.

I have heard *A. microstomum* make a variety of sounds. One is a low piping sound uttered apparently just as the animal comes to the surface and emits air from its lungs. It may be heard at a distance of at least three or four feet. It may not be produced voluntarily. Sometimes the animal will poke its head out of the water and make a low clucking sound, accompanying it with a sudden movement of the throat. It also often produces a grating noise, as if by grinding its teeth together. It may be made to produce this noise by teasing it.

RECENT LITERATURE.

The Requisite and Qualifying Conditions of Artesian Wells.[1]—Chamberlin.—The central purpose of this paper is to call into prominence the varied qualifying conditions that solicit consideration, and, if possible, stimulate and aid those special discriminative studies which lead to an intelligent confidence of success or a prudent withholding from failure. The author thinks it advisable to map off the face of the country into areas of (1) favorable, (2) doubtful, and (3) adverse probabilities. The areas of probable success would be the relatively low tracts, the areas of adverse probabilities, the relatively high regions, and the doubtful belts would be in between.

Ward's Synopsis of the Flora of the Laramie Group.[2]—In this book the author gives a condensed account of the Laramie Group, together with a series of illustrations of fossil plants obtained from the lower series in Colorado and Wyoming, and from typical Fort Union strata in the valleys of the Lower Yellowstone and the Upper Missouri.

Of the latter there are 131 Dicotyledons, 3 Monocotyledons, 3 Coniferæ, and 2 Cryptogams. The synopsis is in the form of tables, which show at a glance the distribution of Laramie, Senonian and Eocene plants, and will therefore be of great service to a palæobotanist.

Scudder's Insect Larva, Mormolucoides Articulatus, from the Connecticut River Rocks.[3] The presence of these insect remains in the Triassic shales at Turner's Falls, Mass., was first made known by Prof. Edward Hitchcock, in 1858, and they were then considered the larvæ of a neuropterous insect. Since that time various opinions have been advanced as to the affinities of these fossils. Recently Mr. Scudder has reviewed the whole subject, carefully examining hundreds

[1] The Requisite and Qualifying Conditions of Artesian Wells, by Thomas C. Chamberlin. Extract from the Fifth Annual Report U. S. Geol. Survey. 1885.

[2] Synopsis of the Flora of the Laramie Group, by Lester F. Ward. Extract from the Sixth Annual Report of U. S. Geol. Survey.

[3] The Oldest Known Insect-Larva, *Mormolucoides articulatus*, from the Connecticut River Rocks. Extract from the Memoirs of Boston Society of Natural History, Vol. III., No. 13.

of specimens, and he gives as a result that "we may look upon the Sialidæ as the group of insects to which Mormolucoides is most nearly allied." Sixteen specimens are figured to show the characteristic differentiation of the segments.

RECENT BOOKS AND PAMPHLETS.

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General Notes.

GEOGRAPHY AND TRAVEL.

Africa.—The Ports of German East Africa.—The coast of German East Africa has few good ports; the Bay of Mikindani is without shelter against the wind and ocean waves; that of Lindi is but the mouth of a river, rendered difficult by a dangerous bar; and those of Kisvara and Kilva-Kivindje are so shallow that ships cannot approach within two miles of the coast. The best port is Dares-Salam. Though the entrance is narrow, and full of reefs, there is at least sufficient depth and full shelter. Baganwyo owes its importance entirely to its proximity to Zanzibar, as the harbor is shallow, as is also that of Saadani. Pangani has a bar, and owes its prominence to the caravans that leave it.

The Boundaries of the Congo Free-State.—The boundaries of the Congo Free-State, as finally determined by the Berlin Conference, and by special agreements with France, are as follows:

(1). On the south. From the mouth of the river which falls into the ocean to the south of Kabinda Bay to the confluence of the Culacalla with the Luculla; then along the meridian of this point until the Luculla is again met with, and along the Luculla to its confluence with the Chiloanga. Along the latter river to its most northern source. From this point eastward an irregular line as far as Stanley-Pool; so arranged that the disputed villages and markets are parted between France and the Free State. The boundary then follows the centre line of Stanley-Pool and of the Congo as far as the confluence of that river with the Ubangi; then up the latter to 4° north latitude, and along this parallel to 30° east longitude.

(2). On the east. The meridian of 30° to 1° 20′ south latitude; then a straight line to the north end of Lake Tanganyika, along the centre of this lake; then a straight line to Lake Moero, in 8° 30′ south latitude; along the centre of Lake Moero, and along the line of the river to Lake Bangweolo.

(3). On the south. A line from the southern end of Lake Bangweolo to 24° east latitude, following the water-shed between the Congo and Zambezi. Along the water-shed of the Kasai, from 12° to 6° south latitude; along the latter parallel till the Quango is reached, and along that river until the parallel of Nokki. This parallel is fol-

lowed until it crosses the meridian of the mouth of the Wango-Wango; then along the Congo from the confluence of the Wango-Wango to the ocean. The western or ocean frontage of the Free State is thus exceedingly short, reaching only from the mouth of the Congo to the south of Kabinda Bay. By royal decree the Free State was, on the first of August, 1888, divided into eleven districts, viz., Banana, Boma, Matadi, Cataracts, Stanley-Pool, Kasai, Equator, Ubangi and Welle, Arawimi and Welle, Stanley-Falls, and Lualaba.

Asia.—Another Russian Journey in Central Asia.—Another Russian traveler, M. Groubtchevsky, has been recently traveling in Central Asia. On his first journey he crossed the Pamir to the valley of the Aksu. At the junction of this river with the Istyk he was arrested by Chinese agents. Having got rid of these by presents, he followed up the Aksu and the Wakhan-daria, but soon met with a detachment of Afghan troops, sent on purpose to arrest Russians. These troops followed him, and camped near him; but in the night he assaulted them, took them prisoners, and made them conduct him to a pass in the mountains. Returning by another route, he traversed the Mustagh glaciers, and followed the course of the Yarkand-daria. Meeting an insurmountable obstacle, he was obliged to return, and direct his march to the north, passing by the peak of Tagharma. Here the food and strength of the Russians were exhausted, and a messenger was sent to Kashgar for supplies. The last news from the traveler announces his safe arrival in Ferghana.

Nepal.—Emil Schlagintweit informs us that the population of Nepal is about two millions. In the east the Tibetan race extends to the valley of Kosi; in the west the Hindu, somewhat mixed, extends to that of Gandach; and between them are located other peoples, coming from Central Asia. Among these tribes are the Leptcha, who are short, and have flat foreheads, pointed chins, and very long arms; the Limbu, who occupy the spurs of the Himalayas, and are neither Buddhists nor Brahmins; and the Hayu, who inhabit marshy spots at the foot of the mountains, and are even less civilized than the Limbu. The dominant people of Nepal is the Gurkha, who are Brahminists.

The Upper Yenesei.—M. Yatchevsky, one of the companions of Colonel Bobyr, notices the distribution of the glaciers in the mountains that separate Siberia from Mongolia. The limit of perpetual snow in this region is about 2,400 metres on the north, and 3,000 on the south side, but there are few glaciers properly so-called. That of Munho-Sardigh is like an Alpine glacier, but most of the

others seem to be disappearing from the dryness of the climate. The region Sayan, watered by the sources of the Yenesei and its affluents, has no trace of a plateau, but is an Alpine country, a mountainous crest, with two rapid slopes.

E. Dulio's Journey from Shoa to Assab.—"Notes of a Journey from Shoa to Assab," by Emilio Dulio (*Cosmos*, Vol. IX., 1888), contains much valuable information upon the habits of the Abyssinians. While King Menelik was absent during his campaign against Harar, the news that he was dead was spread among the Mussulman population, whereupon the Azag Volde Tadik, Governor of the country during the King's absence, having heard of the conquest of Harar and the King's safety, imposed upon every Mussulman the payment of a heavy *tascar,—i.e.*, of funeral expenses for the King they had believed dead. The region of Bahadu Afar is still independent of Shoa. Some of the Afar women are of a most splendid type, while many of the men are, on the contrary, of feminine appearance. The men wear a long sash twisted two or three times round the body, and secured at the waist with the poignard; the women have a single piece of cotton from waist to ankle, secured upon the flank in a loose fashion, so that it often comes undone; in which case the girl takes it entirely off with a graceful and tempting smile, and readjusts it in the presence of male spectators. Married women wear for their principal adornment two anklets so heavy as to render their gait ungraceful. These anklets are the gift of the spouse, are secured by hammering on the occasion of marriage, and are not taken off unless the husband dies first.

South of Shoa the party traversed the plain of Cussurtu, visited the hot springs of Tiho, the mountain Aulia-hali, and the valleys of Galatu and Erole. Then descending into the valley of the Hawash, they came to the smaller branch of the river, and found it dry save here and there a stagnant puddle. Crossing the Hawash, the party reached Gambo-corria, a residence of the Sultan of Aussa. Sr. Dulio believes that the main Hawash can be made a means of communication with Shoa.

The Loess of Central Asia.—According to M. A. Krassnow, the Loess of the Thian-Chan is caused by the action of the rains upon the glacial mud, modified by the dryness of the atmosphere. M. Krassnow has discovered glaciers upon the upper courses of the rivers Zir-tass and Quelu. In the glacial period the glaciers of this region must have been almost equal to those of Europe, as the ice reached to

Lake Issyk-Kul, and covered the chains between it and China. The quality of the ice is different from that of the Alps, and the glacial flora is better preserved than in the latter. On the north-west slopes the plants are the same as those of Europe at similar heights, but upon the south-east slopes the steppe flora rises to 3,000 metres.

Europe.—The Abruzzi.—The part of Italy known as Abruzzo contains about 530 square leagues, and nearly a million inhabitants. It extends along the Adriatic for a length of 200 kilometres, from the river Tronto to the Trigno, is formed by the central group of the Apennines, and contains the highest peaks of that chain. Between the Tronto and the Gizio these mountains form a double line, separated by a series of the most picturesque valleys. The eastern crest is cut through by the Pescara, and is dominated by Il Gran Sasso d'Italia (2,916 metres), the highest mountain in peninsular Italy. Abruzzo is divided into three provinces, now named after their capitals, Christi, Teranco, and Aquila, but properly known as Abruzzo Citeriore, Abruzzo Ulteriore, and Abruzzo Ulteriore II. Among the high peaks of this region are those of Corvo (2626 m.), Malacosta (2,447 m.), Franco (2,135 m.), Scindarella (2,237 m.), Paganica (2,097 m.), Prena (2,566 m.), and Brancatello (2,387 m.). All these crests and peaks, with other lower ones, form an immense group, over which towers Il Gran Sasso.

The Population of Russia.—According to the "Annuaire Statistiquè Russe" for 1885, the present population of the Russian Empire is as follows:

Russia in Europe,	81,725,185
Government of the Vistula (Poland),	7,960,304
Caucasus,	7,284,547
Siberia,	4,313,680
Central Asia,	5,327,098
Grand Duchy of Finland,	2,176,421
Total,	108,787,235

This total comprises 54,063,353 males, and 53,883,042 females, besides 835,840 individuals (in Central Asia) whose sex is not stated. Leaving out Central Asia, the proportion of male to female births is as 106.3 to 100. The excess of births over deaths in Russia in Europe is 13.3 per 1,000 inhabitants; in Poland, 12.7 per 1,000.

The Soil of France.—Recent statistics relative to the present condition of the soil of France are not encouraging. Out of the fifty

millions of hectares of cultivable surface, some four and a half millions, comprising the landes, marshes, heath, etc., are absolutely without culture; more than three and a half millions fallow; four millions are covered with natural, unirrigated pasture in plains, hillsides, etc.; and more than half the forests, comprising nearly five millions of hectares, are without roads, uncared for, and unexplored,—abandoned entirely to nature. Thus more than one-third of the cultivable area of France is practically uncultivated. More than this, the agricultural population, which in 1861 was 19,873,493, had in 1881 decreased to 18,249,209, and the rate of decrease seems to have accelerated since that date.

Geographical Notes.—Two German travelers, Dr. Humann and Professor Haufmann, have taken an archæological journey into the centre of Asia Minor, and have operated in the neighborhood of Aidin, on the site of the Acropolis of Thralles, one of the most renowned centres of antiquity.

Captain J. Jacobsen, already known for his travels in British Columbia, Alaska and Siberia, has, since the end of September, 1887, been exploring the East Indian Archipelago with his friend Kuhne, in the service of the ethnographical museum of Berlin. He has visited Flores, Wetter, Kiffer (a small populous island where the people call themselves Christians, and go regularly to church, and yet worship wooden images), Letti, Moa, Luang, and Babar. Herr Kuhne then explored Ceram, Goram, and Burru, and Captain Jacobsen, Timulant, Timoe, and other islands. The result was a considerable collection of ethnographical material.

Since the death of the illustrious general Prejevalsky, the Russian expedition has been under the direction of Colonel Pievtzov, already known from his geographical researches in Mongolia. A mining engineer, M. Bogdanovitch, accompanied him.

Colonel Bolcheff has published the most complete map of the Pamir that has yet been made. The names are in French, and the French Government has given an academical prize to its author.

The leveling of the southern part of the Siberian coast between Vladivostok and Ussuri has shown that there are no obstacles to the construction of a railroad. Moreover, the engineers have found that the flat and marshy lands to the south of Lake Hanka are of great fertility. Numerous colonists have already established themselves there.

The Chinese have recently sent a scientific expedition into Russia as a sort of response to the numerous expeditions which have visited China of recent years. The chief of the expedition is Miao, a high functionary in the finance department, and the secretary is a savant named Joney, who speaks Russian well. The visitors have been well received, especially at Irkutsk.

Among the very few lakes of South America is that of Tacarigua in northern Venezuela. This was visited by Humboldt, and was then 56 kilometres in length. In 1887 M. Hesse-Wartegg visited it and found that its length was diminished to 49 kilometres. The coasts resemble those of the Lake of Geneva, and its twenty-two islands recall those of lake Pazcuaro in Mexico.

The Pamues, a tribe living upon the lower part of the river Muni, have lately become threatening in their attitude toward the Europeans of the district belonging to Spain, between the Cameroons and the French colony on the Gaboon. As the Spaniards had no available force at hand, the French, who lay claim to part of that coast, had to be called in to protect life and property.

GEOLOGY AND PALÆONTOLOGY.

Contributions to the Knowledge of the Genus Pachyphyllum.—Up to 1870 the genus Pachyphyllum was not supposed by geologists to be represented in any of the American strata. But in 1870, Dr. White described a new species of coral from the Rockford shales, at Rockford and Hackberry, Iowa, as *Smithia woodmani* (Geol. Rep. Iowa, 1870, Vol. II., p. 188). This species was, however, afterwards shown to belong to the genus *Pachyphyllum*,[1] instead of the genus *Smithia*, to which it was at first referred. Again, in 1873, another new species of coral from the same beds was described by Hall and Whitfield,[2] as *Pachyphyllum solitarium*, intimating at the same time, however, that the specimen so referred differed from the generic description of *Pachyphyllum* in its being *solitary*. Since that time we have secured very large numbers of finely preserved specimens of this species, together with one new form from the same beds, as well as a

[1] 23d Ann. Rep. Board of Regents of New York State Cabinet, p. 231.

[2] 23d Ann. Rep. Board of Regents of New York State Cabinet, p. 232.

closely allied new species from the blue shales below the Devonian limestone at Independence, Iowa. A critical study of all these forms showed them to be generically distinct from Pachyphyllum, and to constitute a new and well-marked genus. We have also personally collected from these shales three new specimens of Pachyphyllum, all of which are described in this paper, thus making four species of this genus known to occur in American strata.

The occurrence of the American representative of this genus only in the Rockford shales of Iowa[3] (so far as known) is a fact worthy of note. This fact, together with many others now in our possession, tends to widen the breach between its supposed equivalents, the Chemung group of Hall and Whitfield,[4] and the Hamilton group of Dr. White.[5]

Pachyphyllum woodmani White,—Compare with description of Hall and Whitfield; (23 Ann. Rep. New York State Cabinet, p. 231.) Coral variable; growing in irregular, flat, convex, hemispheric, oblong or semi-circular masses, from single beds three to four mm. in height to corallums twenty-five and one-half centimetres in diameter. Cell walls, more or less strongly exsert, projecting from less than one mm. to more than eleven mm. above the intervening spaces; from three mm. to one centimeter in diameter (the latter dimension, however, is very unusual). Very often situated at one extremity of the area, and rising perpendicular or obliquely to, or even lying flat upon, the surface of the inner cellular space; wall thin or of moderate strength; central depressions very irregular, circular, oblong or ovate in outline, from one and one-half to five mm. in depth. Rays numbering from twenty-five to forty-one, about half of which extend to the elevation or columella in the centre, while the remainder terminate just within the inner wall. Entire cell from three mm. to about two centimetres in diameter, partially limited by a wall formed by the coalescing of the costæ from the adjoining cells. Intercostal and interseptal spaces divided by numerous thin partitions. Usually the great size to which the exsert portion of the cells sometimes attains is at the expense of vertical height; and likewise when a great height is attained, it is at heavy cost to diametrical proportions. In isolated cases the under surface and margin of the corallum exhibit small patches of epithecal crust; and in still more isolated examples, where the exsert portion of

[3] 23d Reg. Rep. New York State Cabinet, p. 236.

[4] Geol. of Iowa, 1870, Vol. I., p. 137.

[5] In some cases this genus is known to be represented in the Devonian limestone which immediately underlies these beds and, in one instance, adjacent to it.

the cell attains the greatest height, they are often annulated at the base and centre by epithecal rings; and budding often takes place slightly below the margin of the cell.

The usual method of growth of this species is by lateral budding almost from the beginning, but sometimes a single cell attains a height of from seven to twelve mm. before new cells are formed. This species, as well as all other species of this genus known to me, are, or were originally (with one known exception) attached to the surface of some shell or other species of corals. The delineation of this species is here based upon over two hundred finely preserved specimens. Its range is, so far as known to me, confined exclusively to the Rockford shales, except in some cases where it occurs in the limestone which immediately underlies them.

Pachyphyllum crassicostatum n. sp.—Coral, very coarse, growing in irregular, convex or slightly branching masses, from one and one-half to eleven centimetres in diameter; central depressions circular, from two to seven mm. in depth; wall very thick and strong. Entire cell from one and one-fifth to about two and one-fifth centimetres in diameter, usually limited by a wall formed by the uniting of the costæ of the adjoining cells; and again, this feature is not always well shown, owing to the great irregularity in growth of some specimens. Rays numbering from thirty-one to sixty, often only half of which extend to the elevated perpendicularly perforate columella in the centre, while the rest run out just within the inner wall. In large specimens the bottom of the cell is sometimes occupied by a well-defined, circular depression, instead of a columella. Rays and costæ continuous, passing down the outside of the cell wall and over the intercellular spaces. Intercostal and interseptal spaces divided by numerous thin, straight or convex transverse partitions.

The usual method of growth of this species is peculiar. Generally a large and very coarse curved cell will attain to the height (following the curvature of the specimen) of five and one-half centimetres or more before budding begins, which then takes place slightly below the margin of the cell, or some distance below. This description is from specimens from Owens' Grove, Cerro Gordo county, and Floyd, Floyd county, Iowa. Specimens of a variety of this species occur at Rockford and Hackberry; and differing from those from Owens' Grove and Floyd in the method of growth (which is generally by budding from the first) in that the coralla do not attain to so great a size, and the bottom of the cells never being occupied by a depression, as well as the (sometimes) slightly less coarse character of the

specimens. This species is known to occur only in the Rockford shales at Owens' Grove, Hackberry and Rockford, Iowa.[6] Although this species is not uncommon at the former locality, yet less than a dozen specimens have been secured from the two latter places during the thirteen successive years that we have collected from these shales. This is a fine species, and cannot well be confounded with any other described in this country.

Pachyphyllum ordinatum n. sp.—Coral compound, growing in regular convex, hemispherical masses, ten centimetres in diameter; point of attachment small. Cell walls abruptly but usually slightly exsert; generally projecting only one and one-half mm. above the intervening spaces; central depressions circular, very regular, three mm. in diameter (rarely a few small young cells are present); entire cells, quite uniform in size and of moderate dimensions, partially limited by a wall formed by the uniting of the costæ from the adjoining cells. Number of rays, from twenty-seven to thirty-two, most of which extend to the slightly elevated centre. Rays and costæ continuous, passing down the outside of the cell wall and over the intercellular spaces. Rays and costæ in well-preserved specimens, slender; but in weathered specimens, strong and broadly rounded or angular. The surface of each cell of this species is slightly concave; sometimes the exsert portion of the cell (which always occupies the centre of the entire cell) is sunk below the outer wall of the cell. This species varies much from *P. woodmani* in its general aspect, the concave surface and greater regularity of the cells, as well as in several other important particulars. Position and locality: Rockford shales, Hackberry, Iowa.

Pachyphyllum crassum n. sp.—Coral usually growing in concave or convex hemispherical masses, from two centimetres to eight centimetres in diameter. Cells usually large, walls strongly exsert, often projecting four mm. above the intervening spaces; central depressions quite regular, from three to five mm. in depth; entire cell from two centimetres in length to one and one-third centimetres in width; when this size is attained, however, it is at the expense of the adjoining cells. At times the large exsert portions of the cells are so crowded together that their bases unite; as many as seven of these projections or elevated portions of the cells have been observed in an area two and one-half centimetres square. Rays numbering from twenty-six to forty-

[6] Since writing the above, a fine specimen has been secured by Mr. Guy Webster from the Devonian limestone which underlies the Rockford shales, one and one-half miles south of Rockford Grove, Floyd county: also numerous specimens have been secured by us from the same limestone at Floyd.

two, all of which appear to extend to the flattened or very slightly elevated centre. Rays and costæ continuous, passing down the outside of the cell wall and over the intercellular spaces. Rays and costæ down to the base of the cell walls alternating in size. The entire under surface of the corallum, except the point of attachment, covered by a strong, wrinkled, epithecal crust. This is a finely marked species, and differs in many important respects from its associate, *P. woodmani.* This species occurs in the Rockford shales, at both Rockford and Hackberry, Iowa.—*Clement L. Webster, Charles City, Iowa.*

On a Species of Plioplarchus from Oregon.—The genus Plioplarchus Cope was established[1] to receive two species of percid fishes, discovered by Dr. C. A. White in a stratum overlying the Laramie formation in Dakota. The writer has called attention to the existence of fishes in the shales near Van Horn's ranch, on the John Day River, Oregon,[2] and has suggested that these shales belong to the Amyzon beds. According to Condon, their position is below the John Day Miocene. Dr. Charles Bendire, U.S.A., obtained, among the collections from that region with which he has enriched science, some specimens of these fishes in a condition sufficiently good for identification. They include four individuals which belong to a single species of the genus Plioplarchus. They elucidate the characters of the genus as follows:

The vomer, premaxillary, and dentary bones carry teeth of small size in moderate numbers. An elevated supraoccipital crest. The lateral line is present, and the scales are feebly cetenoid. The ventral fins are sustained by a spine in front; the number of the rays cannot be made out. The character of the borders of the operculum and preoperculum cannot be determined, but no serrate edges are presented in any of the specimens. Tail furcate.

The specific characters are as follows: the mouth is small, and opens obliquely upwards. Premaxillary and dentary teeth in several rows. Size larger than that of the *P. whitei* Cope, and the scales are less numerous, and of larger size. The spinous rays are less numerous than in that species and the *P. sexspinosus.* Formula; D. xi.–?; A. vii–? 12; the soft anal rays at least twelve, possibly more. Scales in five or six rows above the vertebral column, and in ten or twelve below it. Radiating ridges of proximal portion, strong; disc and distal portion scarcely roughened. Caudal vertebræ, 15.

[1] *Amer. Journal Sci. Arts,* 1882; Tertiary Vertebrata, Cope (Vol. III. Report U. S. Geol. Surv. Terrs.) 1885, p. 727.

[2] Proceeds. Amer. Philos. Soc. 1880, p. 62.

The specimens are all too much injured to permit of complete measurements. The largest measures from the end of the muzzle to the base of the caudal fin 260 mm., and 90 mm. in depth at the vertical fins. The last dorsal spine measures 36 mm. A lateral dorsal scale is six mm. in length.

I propose that this species be called *Plioplarchus septemspinosus*.

The general agreement of this species with the two previously known species of the genus renders it highly improbable that they are widely removed from each other in geological age. Prof. Lesquereux has placed the shales at Van Horn's ranch in the upper Miocene, from the evidence of the numerous plant remains which occur there. As the shales are, according to Condon, below the John Day beds of the middle Miocene, they cannot be upper Miocene of the vertebrate scale. Plioplarchus has not been found in the Amyzon beds, and the plants of that horizon are, according to Lesquereux, different from those from Van Horn's ranch. The shale may then represent a horizon later than the Amyzon beds, but earlier than those of the John Day. In spite of the evidence of the plants, they may be even older than the Amyzon beds, since the bed of the Dakota *Plioplarchus whitei* is not distinguishable stratigraphically from the Laramie at its summit, according to Dr. White, a statement which I can confirm by personal observation.—E. D. Cope.

On a New Genus of Triassic Dinosauria.—In this journal for April, 1887, I described two species of Goniopodous Dinosauria, under the names of *Cœlurus longicollis* and *C. bauri*, from the Triassic formation of New Mexico. I subsequently discovered that they could not be referred to the genus Cœlurus, and placed them provisionally (Proceeds. Amer. Philos. Society, 1887, p. 221) in the Tanystrophæus of Von Meyer. I have recently learned that the reputed vertebræ of the latter genus possesses no complete neural canal, so that the position in the skeleton of these elements, on which the genus was founded, becomes problematical. It becomes evident that the Triassic species in question must be referred to a genus distinct from any hitherto known, differing from Cœlurus in the biconcave cervical vertebræ, and from Megadactylus in the simple femoral condyles, as well as in other points. I propose that it be called Cœlophysis, and the three species, *C. longicollis, C. bauri,* and *C. willistoni* respectively.—E. D. Cope.

The Ophitic Band of Andalucia.—M. Salvador Calderon contributes a study of the epigenic region of Andalucia and of the origin of its ophites to a recent issue of the *Bulletin* of the Geological

Society of France. An ophitic band extends in a W. N. W. to E. S. E. direction from the coast of the Province of Cadiz to the Sierra de Moron; here it bends to the east until it reaches Antiquera, where it again bends northwards, until it dies out in the Province of Jaen. The direction of the band is influenced by that of the cordillera, and its width in general diminishes as it recedes from the coast. Whoever traverses this region is struck by the difference between its orography and vegetation and those of the rest of Andalucia. This ophitic band is not confined to one geological stratum, but traverses Liassic, Neocomian, and lower Tertiary beds, so that the metamorphism has been effected by a similar series of causes acting upon different materials, and therefore producing different results. Throughout the band innumerable points of crystalline rocks exist, and have been designated ophites by Mr. Macpherson, who compares them with similar rocks in the Pyrenees. These ophites occur in masses of no great size and of circular form, and often in rounded hills, covered from the base to summit with many-sided fragments of the same rock. More than four hundred of these ophitic points are known at various levels, and many others must be hidden. Two theories have already been put forth with regard to the origin of ophitic rocks: that of a magma coming from the interior of the globe, and that of chemical deposition, without heat, in the depths of seas, where the débris of primordial rocks have accumulated. This latter theory is sustained by MM. Verlet d'Aoust and Dieulafait.

M. Calderon adds a third theory, which he believes to be the only one that will explain the phenomena to be found in Andalucia and in the Pyrenees. He maintains that ophites are the products of a vast metamorphism produced by orogenic movements upon argillaceous rocks impregnated with divers chemical elements. The relations which always exist between these ophites and the movements which have taken place in the formations in which they lie have long been known to geologists, but, taking the effect for the cause, they have believed that the ejaculation of igneous matter from the interior of the earth has been the cause of the movement of the strata, and also of the chemical transformations. For the region treated of no trace of those phenomena of contact which show the influence of matter in fusion, and no trace of vents of eruption, have been found. The ophitic rock has not penetrated the beds, and usually lies at the bottom of the folds. The clayey and marly beds, permeated with other minerals and with water, have brought together into the cul-de-sac formed by their folds all the conditions necessary for a chemical change, and

denudation has in many cases afterwards brought them to the surface. M. Calderon concludes with these words: "I do not think that it will be too bold to conclude, as a general law, that *when a saliferous formation, rich in marls and clays, magnesia and gypsum, is exposed to tangential force, it must produce the epigenic phenomena known as ophitic, and give birth to true massive crystallized rocks in its anticlinals.*

Vertebrata of the Swift Current River.—No. III.—My second contribution to the knowledge of the fauna of the White River Miocene, as exhibited at the above locality, appeared in the NATURALIST of the present year, p. 151. The researches of Mr. T. C. Weston during the past season, under the direction of Dr. Selwyn, Chief of the Survey, have added a number of interesting points to our knowledge of the fauna, and the following new species:

Menodus selwynianus sp. nov.—Represented by a nasal process, which consists of the coössified nasal bones, of peculiar form. They are elongate as compared with their width, and are vaulted. The lateral borders are nearly parallel, and the extremity viewed from above is rounded. Owing to the thickness of the body, the profile descends abruptly at the extremity, and the convex surface is roughened as though for the attachment of some fixed body, tegumentary or muscular. From this tuberosity the surface descends steeply to a thin border. A short distance posterior to the extremity the lateral margins are decurved, forming the lateral walls of a deep longitudinal median gutter-like nasal meatus, which is deeper than in any other species. The horns are broken off, but the median inferior surface is so little recurved laterally, that it is evident that the former were not only small, but laterally placed. Length of fragment above, mm. 130; length of nasal border, 70; width at nasal notch, 80; do. near extremity, 65; depth at apical tuberosity, 26.

This species is dedicated to Dr. A. R. C. Selwyn, the accomplished director of the Survey of Canada.

Menodus syceras sp. nov.—This species belongs to the group with muzzle and horns of moderate length—the central group of Scott and Osborn. It differs from the two species of that group now known, the *M. proutii* Leidy, and the *M. tichoceras* S. and O., in the very close approximation of the basis of the horns, and the presence of a strong angle or ridge connecting them, so that the nasal bones are in a different plane from that of the front. The entire width of the skull at the basis of the horns is not greater than the length of each horn above the nasal notch. The horns are not long, and the section of their base is a longitudinal oval, flattened on the external side.

Summit subround. The nasal bones are flat, with broadly rounded extremity, and are much wider than long.

The width of the nasals at the base of the horns is 116 mm.; length of do. from do., 70; diameters of bases of horns; anteroposterior, 94; transverse, 67; length of horn from nasal notch, 160; width of muzzle at bases of horns inclusive, 160.

The nasal bones of three individuals present the characters above given. The close approximation of the bases of the horns does not exist in any other species known to me.

Elotherium coarctatum sp. nov.—Represented by a left mandibular ramus with condyle, which supports all of the molar teeth. The species differs from the *E. mortonii*, with which it agrees nearly in size, in having all the premolars in a series uninterrupted by diastemata, except a very short one between pm. iii. and iv. The second premolar is the most elevated, and the third and fourth are abruptly smaller. The fourth has one compressed grooved root. The molars are peculiar in having the two anterior cusps elevated above the three posterior ones, as in Mioclænus sp. The posterior, or fifth tubercle, is well developed, especially on the m. iii.

Length from condyle to edge of canine alveolus, 295 mm.; do. to last molar, 125; do. of true molar series, 67; do. of m. i., 22; width of do., 13; elevation of p. m. ii., 21; length of base of crown do., 28; depth of ramus at m. i., 55.—E. D. Cope.

Geological News.—General.—A geological map of the northern part of Tunis was recently presented by M. Rolland to the French Geological Society. According to a small transcript of the above in the Bulletin, by far the greater part of this region is Pleistocene or Pliocene; but there is a mass of Eocene between Bizerte and Cape Farina, and two others east of the Gulf of Tunis, besides a much larger mass west of Bizerte. Considerable areas of upper Cretaceous also exist west and southwest of Bizerte. On the edge of the Gulf of Tunis the Djebel Bou Kournine rises to a height of 689 metres, and is the first of a series of mountain masses which follow each other toward the south and southwest for 75 kilometres, and which culminate in the Djebel Zaghouan (1340 m.) These mountains are of coralligenous marble, compact, full of debris of encrinites, etc., but as a rule are without determinable fossils. A marly stratum upon which they rest has débris of belemnites. Some remains of ammonites that have been found in the marbles seem to prove that the latter are of Jurassic age.

M. Stuart Menteath has recently made before the French Geological

Society respecting the action of soft strata that have either naturally or artificially been deprived of their original support, some observations that seem to have an important bearing. The great open quarry of the Rio Tinto mines (near Huelva, Spain) is 400 m. long, 200 m. wide, and nearly 100 m. deep. On the southern side there is a mass of clayey schists deprived of support, and having normally a dip to the north. These schists are now taking on, at least near their surface, a dip to the south, and this dip extends at least five metres deep. At the bottom is a mass of solid ore, against which the lower beds of the schists are reduced to powder which is easily washed away by rains, and is expelled by the pressure of the upper layers. This removal causes the settling and gradual overthrow of the upper beds. Not many kilometres distant a similar phenomenon occurs, but here the agent is a torrent which has gradually scooped out a ravine. That which at Rio Tinto has taken place so rapidly that its progress can be noted from month to month, may easily have occurred more slowly in numerous places where the removal of material has been slow; and M. Menteath asks whether it has not often been the case that geologists have estimated the dip of the strata from this comparatively recent, yet in many cases extensive, reversing of the normal dip.

M. W. Kilian recently presented before the French Geological Society a geological description of the Montagne de Lure in the department of Basses Alpes. This work of 458 pages and 11 plates treats of the physical constitution of this mass; of its strata, which commence with the Trias and end with the Tertiary; of the dislocations which have given the chain its present relief; and of its palæontology, with a description of some interesting species found in it.

The new map of the geology of the environs of Paris, on a scale of 1-20,000, is the most complete yet made. The gypsose period is subdivided, and the Pleistocene deposits are carefully shown. Soundings taken in the bed of the Seine have proved that under the river exists a stratum of gravel 10 to 15 metres thick. The highest gravels of the terraces are at Lagny, 19 metres above the Marne, and at Poissy, 27 metres above the Seine. The surface of the chalk is not as much cut up by ravines as was supposed, but has uniform slopes consisting of two synclinal axes and an east and west anticlinal.

Carboniferous.—The Bulletin of the French Geological Society (Nov., 1888, to Jan., 1889) has a note by H. E. Sauvage upon the Palæoniscidæ of the Commentry coal-beds. These beds belong to the upper part of the coal measures. Some 400 specimens of fishes,

most of them in an excellent state of preservation, have been furnished by these beds, and two species have previously been described by Brougniart and by Egerton. M. Sauvage mentions *Amblypterus fayoli, euryi, commentryi, renaulti, elaveris; Commentrya traquairi and C. brongniarti, Elaveria fayoli and E. gaudryi,* and *Comospoma typica,* and gives the leading characters and a side view of the head of each.

Mesozoic.—Numerous species of Jurassic polyzoa, found at Boulogne-sur-Mer, are described by M. H. E. Sauvage in the Bulletin de la Societe Geologique de France, 1889. Five of the species are new.

H. Larrazet describes some fragments of a Steneosaurus found at Parmilieu (Isère, France), in the compact lime-stones of the upper part of the Bathonian stage which furnishes Lyons with free-stone. These fragments present some peculiarities, but the material is not sufficient to warrant the foundation of a new species (Bull. de la Soc. Geol., 1889).

M. P. de Loriol has recently described two species of echini, one from the Senonian of Algiers, the other from the Cretaceous of Turkestan. The latter is made the type of a new genus.

M. Bertrand (Bull. Soc. Geol. France) contributes an interesting note relative to the horizontal folds or *plis couchés* of the region of Draguignan. Some of these folds are so acute that a portion of an older formation is completely enclosed by newer beds.

M. Jules Welsch notes the presence of Gault and Senonian beds in the high plateaux of Oran (Algeria), and remarks that the maximum invasion of the Cretaceous sea over the more ancient strata took place at the lower Senonian epoch.

The Cretaceous strata of a portion of Algeria, with the fossils contained in the different stages, are the subject of a long communication recently made to the French Geological Society. Albian (Gault), Cenomanian, and Senonian horizons are identified, and the Gault and Cenomanian are stated to be unconformable.

Coraster vilanovæ, a small echinid previously believed to belong to the Eocene, has recently been proved to be a Cretaceous species, and has been found in the Pyrenees at Alicante, and also at Tersakhan, near Askhabad (Turkestan).

The geological constitution of the environs de Puy (Haute Dome) from the Eocene to the Quaternary, forms the subject of a note presented on January 21, 1889, to the French Geological Society by M.

M. Boule. The considerable number of fossils favors identification of the beds. The author observes that the region is traversed by faults, a fact seemingly hitherto unperceived by geologists.

M. G. Cotteau, continuing his researches among the Eocene echini of France, has discovered many new species, and described several others which previously had been mentioned but not described. Most of the forms seem to have been local; those of the north of France and of the Paris basin are not the same as those of the southwest, and those of the Pyrenees and of the Mediterranean regions are again different.

M. Landesque (Bull. de la Soc. Geol., 1889), describes and illustrates the Tertiary strata of the Agenais and of Perigord (France). These strata, commencing with the upper Eocene, rest unconformably upon the Cretaceous, and their classification is by no means satisfactorily made out. The lowest bed is a more or less homogeneous mass of sand, colored by oxide of iron, and above this commence alternations of beds of sand and of calcareous clay, in the latter of which have been found six species of Palæotheria, two of Paloplotherium, *Pterodon dasyuroïdes*, an Hyænodon, *Xiphodon gracile*, and some crocodiles and chelonians. According to our author the white limestone of Perigord belongs only partially to the Eocene system, the two upper of the three beds of which it is composed belonging to the Miocene. The quadrupeds of the Miocene beds are much more numerous than those of the Eocene, and comprise species of Mustela, Hyænodon, Cynodon, Amphicyon, Lutra, *Cervus lamilloquensis* (nov. sp.), Palæochœrus, *Anthracotherium lamilloquense* (nov. sp.), Cainotherium, Amphitragulus, *Rhinoceros lamilloquensis* (nov. sp.), Theridomys, Arctomys, Erinaceus, Talpa, etc. There are also many undetermined crocodilians, some chelonians, and numerous *débris* of fishes, birds, batrachians, and snakes. These fossils have been found by M. Landesque at Lamilloque, Caillabet, and Comberatiere, especially at the former places.

M. Paul Gouret contributes to the *Bulletin de la Societe Geologique de France*, a geological study of the marine tertiary of Carry and Sausett (Bouches-du-Rhone, France). The locality is exceedingly rich in fossils, principally gastropods and lamellibranchs, but including some corals and echini.

M. Cotteau has lately presented to the French Geological Society a memoir of the Eocene echini of the province of Alicante (Spain). Seventy-five species, belonging to seven families, are described for the

first time. This is a profusion of echinid species and genera in a limited area surpassing anything hitherto found. Some of the thirty-seven genera are very rare and four are new. These are Pygospatangus, among the Spatangidæ, Stomaporus among the Brissidæ, Microlampas (Cassibulidæ), and Radiocyphus (Diadematidæ).

BOTANY.

The Flora of Central Nebraska.—A botanical collecting field perhaps as interesting as any to be found in the United States is the sand hill region of Central Nebraska. Not particularly interesting from its rare or remarkable flora, perhaps, but from the general ignorance in regard to it. Year after year Eastern collectors have passed over this *arid region* on their road to the Rockies, preferring pleasanter collecting fields.

This summer, while on a collecting trip for the Department of Agriculture, in company with Lawrence Bruner, western entomological agent for the Department, I spent several days on the Dismal and Loup Rivers, in Thomas county, Nebraska. As this is in the very heart of the sand hill region, a few notes especially on the Dismal River trip may not be without interest.

We started for the Dismal River, of which we had heard much from the settlers, in the early morning of the 12th of July. We were accompanied by Mr. Wright, a farmer of the place (Thedford), and Mr. Harper, a sportsman. For several miles we drove up the valley of the Middle Loup River, here a stream about fifty feet wide, averaging three feet deep, and with a remarkably swift current (about eight miles an hour). In the valley the grass is very rank, composed chiefly of *Agropyrum glaucum* R. & S., *Kœleria cristata* Pers., *Elymus canadensis* L., *Panicum virgatum* L., etc., intermixed with sedges, and in places with rank growths of *Onoclea sensibilis* L., and *Aspidium thelypteris* (L.) Swartz.

We soon left the bottom lands, and began climbing the sand hills up over the divide. From all that I had heard of them I expected now a long, tedious ride, but not so. I was surprised at the great variety of flowers we found. We were kept constantly busy pointing out the different kinds and watching the flight of insects. At times we wearied our driver not a little by the frequency of our stops, although for a farmer he was quite a naturalist. The prairies were spotted with the great white flowers of *Argemone platyceras* Link and Otto, and

here and there could be seen the beautiful blue spikes of *Pentstemon cæruleus* Nutt., peeping above the grass or over the edge of some "blow-out," which I notice that they frequent. *Erigeron strigosus* Muhl. dotted the prairie all over, frequently rendering them gray with its little white flowers. Then our common evening primrose, *Œnothera biennis* L., I was not sorry to see, for it was one of my friends, and how rarely beautiful it was, with its unusually large flowers all coming into bloom at so nearly the same time. Perhaps its beauty is somewhat due to the stunted condition it has here in the sand hills. Its relative, the morning primrose I call it, *Œnothera serrulata* Nutt., also added beauty to the prairies with its numerous large yellow flowers. *Haplopappus spinulosus* D. C., *Amorpha canescens* Nutt., *Petalostemon violaceus* Michx., *P. candidus* Michx., *P. villosus* Nutt., *Ceanothus ovatus* Desf., *Eriogonum annuum* Nutt., *Lithospermum hirtum* Lehm., etc., were among the showy flowers of the prairie. We frequently passed bunches of *cactus* of several kinds, but it was too late for their flowers. On one bunch, however, of the common *Opuntia missouriensis* D. C., I found the flowers yet nicely out. It may be of interest to mention that a bud of this particular specimen, after it had been in my press three weeks, when laid out in the sun one day for a few minutes blossomed out as nicely as if in its original sand hills. Fully a month after this, when I opened the package at home containing this, I found that while done up between papers with its flowers perfectly pressed, it had grown a joint fully 1½ inches long.

Our driver told us that we might look for antelope and deer on the divide, but although we saw numerous signs, perhaps fortunately for the scientific interest of our trip we could discover nothing more.

As we approached the divide the region became more hilly, and from here on till we reached the Dismal River grew constantly more undulating, until, with the sand and increasing heat, travel became very tedious. Mr. Bruner's hands, face, and neck were burned to a blister by the hot sun, and my own were no better, About two o'clock in the afternoon, much to our satisfaction, we suddenly emerged from the hills, and descended at first gradually, then abruptly, into the valley of the Dismal River, our destination. We had ridden some twenty miles through sand-hills, had seen but one house,—a deserted sod shanty,—and not a sign of water. We stopped on the bank of the river and began to prepare for dinner. Mr. Bruner and I, with the natural instinct of collectors, started on a trip of discovery to get water, while the others were building a fire. While looking around

on the bank of the creek one of the botanical discoveries of the trip was made. The little *Azolla caroliniana* Willd. (compared with specimens from California distributed by the Department of Agriculture, and one from Florida, collected by Canby), was found in considerable quantity growing in compact patches on the soft, black mud at the edge of the water. Underwood gives us the range of this interesting little plant "from New York to Florida, Arizona and Oregon,"—on both sides of the continent,—and now we have it in the very centre, the Nebraska sand-hill region. Near by, in little stagnant pools, the three duckweeds, *Lemna minor* L., *L. trisulca* L., and *Spirodela polyrrhiza* (L.) Schleid, grew in abundance, while out in the swift stream at this particular point (very common all along, as I observed afterwards) great masses of *Ranunculus aquatilis* L. var. *stagnatilis* D. C., and *Potamogeton* sp., waved back and forth with the current. The profusion of the small white blossoms of the former, with the background of green readily seen beneath the water, gave a pleasing effect. A spring was soon found, and with water we returned to dinner.

The appearance of the Dismal River at this point is very striking. A half mile away one would never suspect the presence of more than a small "draw" at most, but soon one begins a rapid descent, and suddenly we look over a small bluff, and there below us a hundred feet spreads out the green valley of the Dismal River. A small valley, indeed, here only about seven hundred feet in width, but from its location the most interesting I have ever visited. Turn this way, and one sees only sand-hill after sand-hill, stretching away as far as the eye can reach, the air over them quivering with the heat of an almost tropical sun ; face about, and there below is a green wooded belt, with underbrush in places forming almost a jungle, and, winding in and out, a clear, rippling stream. The coolness of the shaded valley seems to come rolling up in waves, enveloping the hot and tired collector as he gazes.

The bluffs on the south of the valley rise abruptly to the height of almost three hundred feet. At one time they were heavily wooded with the red cedar (*Juniperus virginiana* L.), of which a few remain, but settlers for miles around depend upon this for their fuel and post-wood. The brush from cut trees was thrown in rows, about a rod apart, extending up the bluffs, and a fire lately burned over great patches of this, doing much damage to standing trees, so that now from a distance the bluffs present a striking black and grayish-striped appearance.

After dinner we entered the wooded valley and began our search. Almost in the edge of the water near our stopping-place rank stems of *Glyceria arundinacea* Kunth., three feet high, and with a panicle about sixteen inches long, were gathered. This is not a rare species in many places, but has not been noted before for Nebraska. Near this, and still in the edge of the water, were *Glyceria nervata* Trin., and the common *Panicum virgatum* L. The trees commonly found growing in the valley were *Celtis occidentalis* L., *Prunus americana* Marshall, *Prunus demissa* Walpers, *Ulmus americana* (L.) Willd., *Cornus stolonifer* Michx., *Negundo aceroides* Mœnch., *Populus monolifera* Ait., *Salix longifolia* Muhl., *Rhus glabra* L., and in isolated patches or clumps *Shepherdia argentea* Nutt. The latter is found also on the edge of the bluffs above.

In the woods specimens of *Elymus striatus* Willd., *Agrostis exerata* Trin., and *Impatiens pallida* Nutt., were collected. The latter was very badly rusted (*Æcidium impatientis* Schw.). The rather rare grass *Oryzopsis micrantha* (Trin. and Rupr.), never before catalogued for Nebraska, grew in the edge of a pond, and near it, on wet, sandy soil, *Alopecurus geniculatus* L. var. aristulatus (Michx.) Torr.

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[To be Continued.]

ZOÖLOGY.

Professor H. Gadow on the Homologies of the Auditory Ossicles.—The homology of the auditory ossicles does not seem to be yet settled. The last contribution to the subject is that of Herr Hans Gadow, now Strickland curator and lecturer on the advanced morphology of the Vertebrata, at Cambridge, England. (Philo. Trans. Royal Society, London, 1888, Vol. 179, pp. 451–485.) Professor Gadow carries the history of the first and second visceral arches through the entire vertebrate series, and illustrates his memoir with four quarto plates, which give the results of his labors. The possession of an ample collection of rare Elasmobranch forms, especially Heptanchus, Hexanchus, Centrophorus, Myliobates, and Trygon, with several fresh examples of Sphenodon, motived the examination of the question. Professor Gadow finds that in the Notidanidæ the first and second

arches do not articulate with each other, but that in all remaining Elasmobranches there is a suspensorial arrangement. In Centrophorus, Mustelus, and Acanthia there is no direct contact of the two arches; in Oxyrhinia and Sphyrna the hyoid and mandible have developed articular facets for contact, whilst the hyomandibular does not; but in Galeus, Scymnus, Cestracion, and Trygon the hyomandibular and mandible are in contact. In Trygon the former is also in contact with the quadrate portion of the first arch.

The Dipnoan and Batrachian series show the gradual and finally absolute estrangement of the hyomandibular-hyoid arch from the palato-quadrato-mandibular arch, leading to the loss of ligamentary connection, and to the final attachment of the hyoid to the cranium. The hyoid becomes completely separated from the hyomandibular, which would have aborted completely had it not assumed new—namely auditory—functions, by becoming connected with a tympanum, *i.e.*, a cavity formed out of the first visceral cleft. The hyomandibular, invested with this new function, breaks up into two or more pieces, as an ossicular chain. The old piscine ligamentous, or even cartilaginous, connection between hyomandibular and mandible is lost in the Salientia, and in the Urodela a piece of cartilage, comparable either with a symplectic or an opercular element, is also gradually lost. The tympanal end of the auditory chain or rod becomes connected with the cranium by a suprastapedial element, probably of periotic origin, while the quadrate becomes reduced to a small cartilage wedged between the elongated pterygoid and squamosal. This elongation of the pterygo-quadrate bar, transposing the masticatory joint outwards, away from the cranium, has caused, or at least facilitated, the separation of the hyoid from the hyomandibular. In the Chelonia the broad quadrate is fused with the skull. In the Trionychidæ and land tortoises (as shown by Peters) the quadrate forms a closed canal through which passes the columellar rod, but in other tortoises and turtles it forms an imperfect canal, open behind and below. In all chelonians the interfenestral apparatus consists of two pieces, and the hyoid is frequently either absent or is a mere bit of bone or cartilage attached to the basilingual plate. The pair of long bony bars which act as hyoid is really the third visceral or first branchial arch. In the Crocodilia the auditory apparatus is very complex. The air cavities of the os articulare are connected with the middle ear or tympanic cavity by the fibrous and partly cartilaginous siphonium. The air-cavities of the quadrate are also in direct communication with the tympanic cavity. The outer end of the columella proper possesses a concave facet, by

which it articulates with the short basal stem of a trifid extra columellar cartilage or malleus. The lower process of this trifid malleus is connected with the mandible by a cartilaginous or partly ligamentous string, for the reception of which the quadrate forms a bony canal.

The whole string is originally cartilaginous. The hyoid arch has entirely disappeared as far as ceratohyal and stylohyal pieces are concerned.

In Sphenodonia the top end of the hyoid is fused with the extracolumella. In Gecko it is attached to the cranium, as in the Mammalia, but in most lizards the proximal portion of the hyoid is removed from the skull, and remains otherwise well developed. In the Ophidia and in birds, as in Crocodilia and Chelonia, the proximal part of the hyoid becomes reduced and lost. In Ophidia and in Chamæleo the extracolumella gains an attachment to the quadrate, squamosal or pterygoid, while its connection with the mandible and the tympanum is lost. The chamæleon has no tympanum, and those parts of the extracolumella which in other types would be attached to the tympanum, are here attached to and fused with the quadrate. In birds the arrangement of the auditory ossicular apparatus is very similar to that of the monitors. In the adult the whole hyoid bar is absent, with the exception of a small cartilage.

In mammals, as is well-known, the ossicles of the ear are usually four, although the small lenticular element which lies between stapes and incus frequently remains cartilaginous, and is occasionally absent. The hyoid has no connection with either mandible, palate, quadrate, or with the ossicular chain, but its upper end is fused with the cranium behind the tympanic ring. Many various views have been held respecting the origin of the auditory ossicles. Tindemann (1810) held that the entire ossicular chain of mammalia was equivalent to the columella of birds and reptiles, and that the quadrate equals the zygomatic process of the squamosal. Reichert (1837) derived the malleus from the articular element of the mandible, the incus from the quadrate, and the stapes from the end of the hyoid. Gegebaur agreed with Reichert as regards the mallėus and incus, but derived the lenticulars and the stapes respectively from the symplectic and the hyomandibula. Peters (1867) held that all the ossicles were developed from Meckel's cartilage, and that the quadrate had become the tympanic bone. Huxley (1867) and Parker both held that the quadrate of birds and reptiles became the malleus of mammals, and that the incus and lenticular were derived from the hyomandibula. Huxley also held that the stapes is of hyomandibular origin, but Parker was inclined

to derive this element from the auditory capsule. Parker's later view derived the malleus from the articulare, and the incus from the quadrate. Salensky (1880) held that the malleus and incus came from Meckel's cartilage; Fraser (1882) derived the malleus from the end of the mandibular cartilage, and the incus from the proximal end of the hyoid, whilst Albrecht (1883) traced all the ossicles to the hyomandibular, and held that the quadrate was present as the zygomatic process of the squamosal. Gradenigo (1887) agrees with Salensky with regard to the malleus and incus, but derives the stapes from the hyomandibular and periotic cartilage.

Prof. Gadow agrees with Peters in making the quadrate bone equal to the tympanic bone of the mammals, and states that no animal possesses both an os tympanicum and a distinct quadrate bone. The Salientia have indeed a tympanic ring, which Prof. Gadow, on Balfour's authority, derives from the metapterygoid region of the quadrate. He agrees with Albrecht in deriving the ossicles of the middle ear from the hyomandibular element of the second visceral arch. This last speaker upon the vexed question of the homologies of the suspensorium and ear bones therefore supports Albrecht in the main points of his thesis, but differs in regarding the tympanic bone rather than the zygomatic process as the representative in the Mammalia of the sauropsidan quadrate.

Prof. Lankester on Amphioxus.—E. R. Lankester contributes to the *Quarterly Journal of the Microscopical Society* (April 29, 1889) a number of valuable particulars concerning the anatomy of the lancelet, with special reference to numerical characters. In the living animal the atrial chamber projects between the lateral ridges or metapleura. Between these metapleura the ventral wall is in the living animal plaited into longitudinal folds, six or eight upon each side of the middle line; but when the generative products are full grown these folds disappear. A large drawing taken from life shows these folds. There are not any canals below these ventral plaitings, as was believed by Stieda, Rolph, and others. *Branchiostoma lanceolatum*, the species found at Naples, has on an average 61 myotomes; *B. elongatum*, from Peru, has 79; *B. bassanum*, from Bass's Straits, has 75–76; *B. belcheri*, from Borneo, 64–65; *B. caribbæum*, from Rio de Janeiro, 59–60; and *B. cultellum* has 52. The full number of myotomes is acquired at a very early period of life, even before the epipleural chamber is complete. The true mouth is the small median aperture concealed by the oral hood, which latter is really a preoral portion of the epipleural folds.

Twelve delicate tentacles project from the mouth into the pharynx. The atriopore seems to coincide with the thirty-sixth myotome, the anus with the fifty-first. The formula would, therefore, be 36–15–10–= 61. The number of dorsal fin rays is 250–260, although there are none over the last six myotomes; there are thus about five to a myotome; but there does not seem to be any fixed relation between the two numbers, especially as the ventral fin rays are proportionately less numerous,—thirty-four or rather more in twelve myotomes. The fin rays lie in a compartmented lymph-space, which is antecedent to the rays and extends beyond them, both fore and aft. The cœlomic sacs, in which the reproductive cells develop, correspond to twenty-six myotomes. The pre-oral tentacles vary in number, but are always fewer in young examples. They are formed in pairs. After the larval phase is passed all relation is lost between the number of myotomes and that of the gill-slits, which latter numbered ninety-six in specimens a little under an inch in length, and one hundred and twenty-four in larger examples. Each primary gill-slit is borne upon a solid chitinous rod, and each becomes secondarily divided by the growth of a tongue in the direction of the length of the slit: these tongues are carried upon hollow chitinous rods.

The body contains three kinds of spaces, which are filled with lymph: (1) the atrial chamber, (2) the enteric spaces, (3) the hæmolymph cavities. An atrial cercum extends back to beyond the atriopore. The enteric cavity consists of atrium, intestine, and cæcum, the last given off as a diverticulum at the 28th or 29th myotome, and reaching forward to the 14th or 15th in adults. The vascular system seems to be in a state of degeneration. Certain of the vascular trunks are continuous with the lymph spaces, so that the vascular and lymphatic systems cannot be distinguished. The metapleural lymph canals disappear when the gonads are ripe, and it does not appear improbable that their lymph serves as a final supply of nutriment to the gonads.

Dr. Lankester has discovered two short, wide, brown funnels opposite to the 27th myotone; the wide end turned toward the atrium, the narrow directed to the dorso-pharyngeal cœlom, and thus serving to place the latter in communication with the former. Dr. Lankester's memoir is illustrated with five plates.

Note on Ammocoetes Branchialis (Linnæus).—Previous to the fall of 1885 we had no positive record of this species from localities other than from Central and Southern Indiana, and from Southern Wisconsin. On May 8, 1886, Professor S. A. Gage and

myself discovered several specimens of this species in Cayuga Lake Inlet, five of which we captured.

One year ago Professor F. Star informed me that they were seen by him in the spring, in large numbers, in the small streams tributary to the Cedar River, Iowa.

This spring I collected about sixty specimens in a small brook from two to five feet wide, near Cedar Rapids, and many others were seen, all in a distance of about three-fourths of a mile.

In 1886 we compared the five specimens from Cayuga Lake Inlet with as many more specimens from Indiana, noting only this difference: in the Inlet specimens the extreme mandibulary cusps were larger than the inner ones, while in the specimens from Indiana all the cusps were subequal.

Dr. B. G. Wilder has kindly sent me twenty specimens from Ithaca, N. Y. These I have carefully compared with the specimens collected near Cedar Rapids, and am convinced that all are of the same species.

In most of the specimens the outer mandibular cusps are larger than the four others. In other specimens the cusps are subequal. The usual number of cusps is six. Occasionally a specimen is found with seven cusps, and rarely one with five.

There is no crest developed on the back of either sex during the breeding season, as is so characteristic of *Petromyzon marinus*. About one-fifth distance from the vent to the end of the tail a small fin-like crest is developed on the male. There is also a similar crest on the female, which is larger, less firm, and more fin-like.

The dorsal fins on both males and females are situated on a small crest, which is more conspicuous on the males.

The number of muscular impressions between the last gill opening and the vent vary from sixty-five to sixty-eight.

A microscopical examination of the zoösperms shows those in both the specimens from Ithaca, N. Y., and Iowa, to be of apparently the same shape and size. The head is large and prismatic, with a long, slender tail, which usually has an enlargement near its posterior end. It is quite evident that this species is far more widely distributed in this country than was formerly supposed, and it will no doubt be found in all streams in the Mississippi Valley, at least north of the lower Ohio rivers.

Early in the spring they leave the larger streams, and ascend the smaller streams to deposit their eggs, which occupies from one to two weeks. They make their nests in the bed of the stream by excavating

Arthropoda.—M. Nussbaum has seen two polar globules in the cirripede egg (*Zool. Anzeiger, 301*). The first is formed while the egg is in the ovary, the second after fertilization in the egg sac.

Vertebrata.—Dr. R. W. Shufeldt publishes (*Journal Comp. Med. and Surg.*, Apr. 1889), an account of the osteology of the hawk, *Circus hudsonius*.

Mr. S. Garman (Bulletin Essex Institute, XX.), has collated the references to the Batrachia in the various editions of Kalm's Travels in North America. The result is to overturn some of the nomenclature of our frogs and toads.

EMBRYOLOGY.

Homologues in Embryo Hemiptera of the Appendages to the First Abdominal Segment of other Insect Embryos.—While preparing a paper on the appendages of the first abdominal segment of the embryo *Blatta germanica* for the Proceedings of the Wisconsin Academy of Sciences, Arts and Letters, to be published during the coming summer, my attention was drawn to the Hemiptera, on which no observations have as yet been made in regard to appendages to the first abdominal segment. The pair of appendages which appear on this segment in embryo Orthoptera, Coleoptera and Trichoptera remain short, but become bulbous, and persist in some cases till the larva hatches. All investigators agree that in these three orders the curious appendages reach their greatest development during the revolution of the embryo. They have been regarded by Rathke, Ayers, and Graber as embryonic gills, by Patten and myself as glands.

The two species examined by me were *Cicada septemdecim* and *Nepa cinerea*, which represent two of the three large divisions of the Hemiptera.

In both cases the appendages persist as in the Orthoptera till after revolution, but instead of being *e*vaginated as in the insect embryos heretofore investigated, they are *in*vaginated. The shape of one of these appendages is bulbous, and its pyramidal cells are radially arranged with their broader basal ends turned inwards and their tapering outer ends terminating on the surface of the body. In *Cicada* there are few cells in the organ, in *Nepa* a much greater number.

In *Cicada* a glairy, much vacuolated mass is secreted by the tapering outer ends of the cells, and projects into the space between the body

of the embryo and the egg envelopes. This space is filled with the coarsely granular secretion which before revolution filled the cavity of the amnion. The glairy secretion of the invaginated appendage stains pink in borax-carmine, and is distinctly marked off from the amniotic secretion.

In *Nepa* the secretion of the pyramidal cells differs from that in *Cicada* in a remarkable manner. The tapering ends of the cells are very delicate and transparent, and the secretion from the tip of each cell is not confluent with the secretion from the neighboring cells to form a glairy mass as in *Cicada*, but assumes the shape of a thread fully as long as the cell which secretes it, and protrudes into the space between the body wall and the egg envelopes. As the secretion of each cell remains thus independent, the secretion of the whole organ strikingly resembles a brush or a bundle of cilia.

I conclude that the *in*vaginated bulbous bodies in the first abdominal segment of Hemiptera are the homologues of the *e*vaginated bulbous appendages in other insect embryos from the following facts:

1. These organs in Hemiptera are two in number, and appear only in the first abdominal segment, in positions held by the evaginated appendages in other insect embryos.

2. They are ectodermic in their origin, like the appendages in other insects.

3. They have the same shape and cytological structure as the evaginated appendages of the first abdominal segment in Orthoptera and Coleoptera.

It is obvious that the invaginated appendages of the Hemiptera could never have functioned as gills, and their complete similarity in minute structure to the protruding bulb-shaped or even lamellar abdominal appendages of embryo beetles is strong evidence against Graber's and Ayer's supposition that these organs are respiratory in the forms heretofore studied.

On the other hand the supposition of Patten and myself that these organs are glandular, receives strong confirmation from my observations as briefly given above. My observations also make more plausible the supposition that the lung hooks of scorpions and spiders are the homologues of evaginated appendages.

I reserve a more complete and illustrated description of my results for future publication.—W. M. WHEELER, *Public Museum, Milwaukee.*

Observations on the Placentation of the Cat.—The following preliminary notes are offered in advance of the publication of an illustrated paper on the same subject.

The stages studied were from three days after impregnation to maturity.

All sections were cut with the embryo *in situ*. In the earliest stage examined little or no swelling was noticeable on the external surface of the uterine cornu. Sections through the cornu showed that the presence of the egg had induced very great changes in the mucosa; the most noticeable change being its increased thickness. In the stages immediately following the mucosa with its glands is turned inwards at both poles of the cavity, forming heavy lips around each pole of the latter. A little later the cavity containing the embryo becomes barrel-shaped, but remains so only a short time. The uterine glands become contorted, and extend peripherally almost to the annular muscular coat. The swelling of the cornu seems to be greatest on the side opposite the mesometrium. This is probably due to the fact that at that point there is least resistance. The spherical fœtal membranes touch the mucosa in an annulus about the embryonic or blastedermic vesicle, as they must necessarily do on account of the form of the latter and the tube in which it lies. The poles of the embryonic vesicle which do not come in close contact with the mucosa are, however, very small during the early stages.

The rapid growth of the embryonic vesicle seemingly expands the cavity of the cornu, and as the cornu does not become enlarged beyond each pole of the vesicle the mucosa must necessarily touch the chorion at all points except over a very small area at each pole.

In the succeeding stages the glands become very glassy in appearance, and contractile muscular bands were noticed about each gland, their function probably being to force out the "uterine milk," or secretion for the nourishment of the embryo at this stage.

Later, when the velli of the permanent chorion are developed, the glands cease their activity, and are transformed into crypts to receive the velli of the chorion. The glands at the poles remain unchanged. Their axial ends are turned towards the embryonic vesicle. They retain their contorted or spiral form and vascular appearance. The contact of the chorion and mucosa at this early stage determines the size and position of the placental zone. The placental zone increases its diameter and width slightly, but it does not increase in width as fast as the cavity containing the embryo elongates. It reaches its maximum width at a time when the embryonic vesicle is about one inch in diameter and almost spherical in form. The axial ends of all the uterine glands, in the cavity containing the embryo, beginning with the earliest stages, are pushed *from* the mesometrium, and on

the side opposite the mesometrium they are much shorter. These facts can probably be explained as a result of the increase in size of the embryo, during which it meets with the least resistance at the free side of the cornu, the swelling consequently increasing more rapidly on that side, while the axial ends of the glands are drawn down from the mesometrium, and those on the free side of the cornu are compressed.

During the early stages the axis of the embryo lies transversely to the axis of the cornu, but when the uterine cornu reaches a diameter of about one and one-eighth inches the embryo changes its position, and remains with its axis parallel to the axis of the cornu; the ventral side of the embryo is toward the mesometrium. About this time the placental band or zone, at a point diametrically opposite the mesometrium, undergoes atrophy, which in the last stages almost severs the placental girdle as a groove in its inner face. In this attempt at a break in the continuity of the placental zone, the cat resembles the squirrel, in which, as Professor Ryder has shown, so much of the zone is atrophied that only a square piece of the original placenta remains.

The blood supply of the maternal portion of the placenta is very noticeable at this stage. The sides of the crypts are well supplied with very large capillaries, and supported on the inner ends of the crypt are large vessels carrying maternal blood, forming a vascular mesh-work through which the crypts open into the uterine cavity.

The peripheral ends of the uterine glands are not transformed into crypts, but seem to form a layer of spongy tissue, the decidua, and it is very probable that at parturition a portion of the degenerate epithelium of the crypts adheres to the muscular walls of the cornu, and reproduces the mucosa.

During the growth of the embryo the annular muscular band undergoes considerable change. Its fibres are turned from their normal direction, and run obliquely over the uterine dilatation. At the end of gestation the length of the uterine cornu is about twice that of the non-gravid uterus.

This study was conducted in the Biological Laboratory of the University of Pennsylvania, under the direction of Professor Ryder, to whom I would express my obligations for the valuable aid which he extended during its prosecution.—M. J. GREENMAN.

Mr. Hy. Orr (*Quart. Jour. Micr. Sci.*, Dec., 1888) gives some detailed observations on the development of *Amblystoma punctatum* (or *A. bicolor*) and of *Rana halecina* (or *R. palustris*), with special reference to the central nervous system, and with notes on the hypophysis, mouth and appendages, and skeleton of the head. The central nerve-system first appears as a transverse epiblastic thickening, continuous with paired elongated epiblastic dorsal thickenings. The first nerve-fibres of the brain appear on what was originally the internal surface of the primitive dorsal epiblastic thickenings. A subsequent development of nerve-fibres gives rise to a continuous ventral commissure and to the anterior and posterior commissures of the brain.

Mr. Orr considers the balancers of Amblystoma as external gills of the mandibular arch, which have become metamorphosed into embryonic organs of support.

PHYSIOLOGY.[1]

Heart-sounds.—The well known experiment of Ludwig and Dogiel, who, by excluding the blood from the heart and presumably throwing out of function the atrioventricular valves, still heard the first heart-sound, is interpreted as evidence of the preëminently muscular character of that sound. Krehl,[2] working in Ludwig's laboratory, finds yet stronger evidence of similar nature. Through the auricles he introduces a simple apparatus by which, at will, the atrioventricular valves may be held back against the cardiac walls, and thus thrown out of action or not interfered with. Observers, even physicians skilled in auscultation, are unable to perceive any differences, either in intensity or character, of the sound, whether the valves are in use or not. Bleeding the animal from the carotid does not interfere with the first sound until shortly before death, when the sound becomes feeble in accordance with the feeble beat of the heart. The experiments do not elucidate the question whether the heart-beat is a single twitch or a tetanus; if it be the former, the sound may easily be explained, as Ludwig himself has previously suggested, by the pulling or rubbing of the muscle fibres on each other. If the ventricular contractions be excluded, a distinct but feeble auricular sound is heard. This may doubtless explain the "galop-rhythm," which is characterized by the

[1] This Department is edited by Dr. Frederic S. Lee, Bryn Mawr College, Bryn Mawr, Pa.

[2] Du Bois Reymond's *Archiv*, 1889, p. 253.

appearance of an extra sound preceding the recognized first sound, and is rightly regarded as indicative of some pathological condition.

Mechanism of Tricuspid Valve..—Krehl[3] publishes a careful and detailed account, illustrated by good figures, of the action of this valve during the whole cardiac cycle.

Innervation of Renal Blood Vessels.—J. Rose Bradford's work[4] adds to our knowledge, hitherto defective, of this subject. Roy's oncometer was used and the tracing of the volume of the kidney was compared with that of the general blood pressure. The main conclusions are as follows:

1. All renal vaso-motor fibres leave the spinal cord through the anterior roots, and although a few fibres may come out as high as the 4th dorsal, it is not until the 6th dorsal is reached that they are found in any abundance. From the 6th dorsal to the 13th dorsal they are abundant; below this they are found in rapidly diminishing numbers, so that but little vaso-motorial effect is seen to follow the excitation of the 3d and 4th lumbar nerves.

2. These renal vaso-motor fibres are of two kinds, vaso-constrictor and vaso-dilator. The former are, however, by far the best developed, so that unless special methods, such, for example, as slow stimulation, are used, it is rare to get clear evidence of vaso-dilatation on excitation of any given nerve.

3. The kidney vessels receive their nerves from all the spinal nerves included in this extensive series, but most of the renal vaso-motor fibres are found in the 11th, 12th, and 13th dorsal nerves.

4. No evidence has been obtained of the existence of any vaso-constrictor fibres for the kidney vessels in the vagus nerve. The splanchnic nerve contains not only vaso-constrictor but also vaso-dilator fibres for the vessels of the abdominal viscera, and for the renal vessels amongst the rest.

5. By reflex excitation of the renal nerves through the sciatic, intercostal or vagus, active renal contraction is obtained: through the depressor, active expansion, which is, however, usually neutralized and changed into passive contraction by the great dilatation elsewhere; through a posterior root, especially of the 11th, 12th, and 13th, active expansion, due to the stimulation of afferent visceral nerve fibres. Occasionally reflex excitation produces general dilatation, and then the

[3] Du Bois Reymond's *Archiv*, 1889, p. 289.

[4] *Journal of Physiology*, Vol. X., 1889, p. 358.

kidney (although its vessels share in the dilatation) undergoes passive shrinking. There is no evidence of decussation of vaso-motor fibres in the splanchnic, *i.e.*, the right splanchnic sends fibres to the right kidney only, not to the left.

Physiology of the Heart of the Snake.—In the Canadian *Record of Science*, Vol. II., No. 8, Oct. 1887, is given an account by T. Wesley Mills of a study of the heart of the snake, which closes with the following summary:

1. The investigations recorded in this paper were made in mid-winter, on fasting but not hibernating animals.

2. Comparison of the vagi showed that in every instance both nerves were efficient; but usually the right was the more so; in some cases the difference, if actual, was minimal.

3. Stimulation of the vagi leads to after increased force and frequency of beat, or the former only, and according to the law of inverse proportion previously announced by the writer.

4. The mode of arrest of the heart is identical with that noted in chelonians, fish, etc.; the same applies to the mode of recommencement.

5. During vagus arrest, the *sinus* and *auricles* are inexcitable.

6. There are certain peculiar cardiac effects not explicable by reference to the vagi nerves alone, but which put the sympathetic system of nerves in a new light.

7. Direct stimulation of the heart confirms results previously noted by the writer for other cold-blooded animals. Arrest is, in all the animals of this class yet examined, owing to stimulation of the terminals of the vagi within the heart's substance.

8. As regards independent cardiac rhythm, the results have been negative.

9. The heart of the snake, upon the whole, seems to lie physiologically between that of the frog and that of the chelonians. X.

ARCHÆOLOGY AND ETHNOLOGY.

Aboriginal remains near Old Chickasaw, Iowa. On the west side of the Little Cedar River, about one and one-half miles below Old Chickasaw, Iowa, are located ten mound-builder mounds.

The same locality, by disease, war, emigration, or other causes, may have been depopulated and again repeopled by other races, each

of which in its turn may have erected mounds for burial purposes, religious purposes, points of observation, or for other uses. The word mound-builders, therefore, as generally used, is calculated to lead to error by the implication that the habit of mound building was peculiar to *one* prehistoric race. In this paper the term mound-builder is applied to that prehistoric race (doubtless represented by numerous tribes) which, in ancient times, prior to the advent of the red Indians,[1] occupied much of that region now comprised within the bounds of the United States.

The mounds near Old Chickasaw are situated upon the border of the first terrace of the stream, as shown in Fig. 1, and which rises from twenty to forty-five feet above the flood plain at its base. Back from the first terrace, two hundred and sixty yards, is a second terrace, which rises sixteen or eighteen feet above the first one.

The country back from this terrace increases gradually in height until within three-fourths of a mile it has attained an elevation varying from twenty feet to more than one hundred feet above the last bench.

About two hundred and sixty yards to the southwest from the mounds, a never-failing spring of water issues forth from the base of the second terrace, and a short distance below a second one rises from the same region.

This entire region was formerly occupied by a heavy growth of timber; but much of it has now been cleared away by the settlers in opening up farms. The limited view (owing to the presence of timber) obtained from the site of these mounds, although pleasing, is yet far inferior to the beautiful and extensive scene afforded from the elevated land back from the stream a short distance.

All the mounds of this series are circular, with oval tops, and have a diameter varying from twenty-two feet to fifty-one feet, and a height of from one and three-fourths feet to five feet.

The distance between the different mounds is variable, being from two feet to fifty feet.

The main line of mounds, as will be observed by referring to Fig. 1, runs north a few degrees east. The remaining mounds are located approximate to and run parallel with the main line. In the centre of the first mound examined (No. 3) three human skeletons were found.

These bodies, many of the bones of which were in a good state of preservation, had been placed on the original surface in a sitting posture, and the mound reared over them.

[1]In the light of recent discoveries, it is difficult to say what portion of the so-called "Mound-builder race" was not identical with the red Indians.

The first body sat facing the east, and the second one directly in front, with knees nearly touching, facing the first one.

A few inches to the north of No. 1 a third one had been placed, apparently facing the east. The crania of all three individuals showed an extremely low grade of mental development; the foreheads being, in one case, even lower than in the specimen found in the Floyd mound, which was figured and described by the writer in a paper on "Ancient Mounds at Floyd, Iowa," that appeared in a late number of the AMERICAN NATURALIST.

The upper anterior portion (back of the eyes) of one of the crania under consideration was quite narrow, but rather rapidly expanded postero-laterally. That portion of the frontal bone forming the upper part of the eye sockets attained a height of only from four to seven mm.; and then sloped abruptly backward, forming a slightly *concave* area back of and above the eyes. This cranium, as well as the others obtained from this mound, was smaller (the largest 6¼x5 in.), than the Neanderthal skull.

In Plate XXIX. is given a good representation of one of these strange crania.[2]

One of the individuals was apparently that of a woman in middle life, while the body on the left was that of an aged person.

The first one and one-half feet of material above the remains was a mixture of earth and ashes, made very hard, with a few small pieces of charcoal scattered through it.

The remaining three and one-half feet of material composing the mound was a yellow, clayey soil, unlike anything found on the surface in the vicinity.

Five feet below the surface of mound No. 4, and resting on the natural surface of the ground, were the remains of two persons which had been buried in a sitting position.

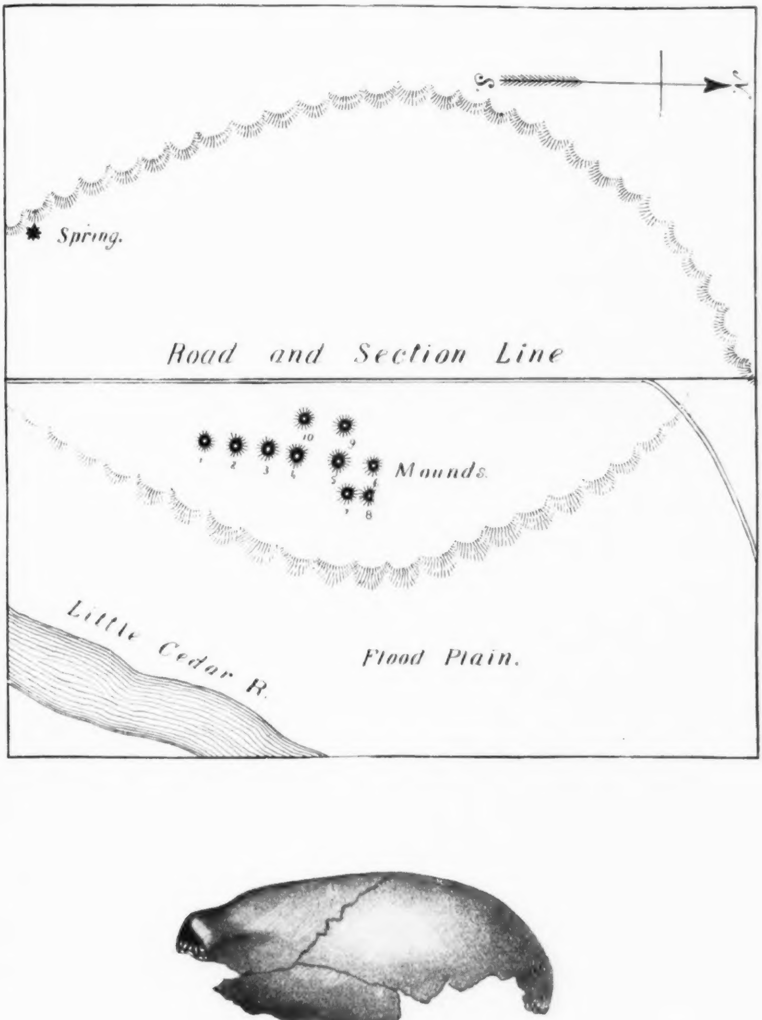
Some of the larger bones of the bodies were in a good state of preservation; the crania, however, were too badly crushed and decomposed to allow of a reconstruction of their parts.

The structure and size of the bones of these individuals indicated persons of great muscular development, and showed them to have been at least six feet in height.

The first three and one-fourth feet of the mound above the remains was yellow earth and ashes, made very hard, probably by tramping and the use of water.

[2] This cut does not represent the most inferior cranium secured.

PLATE XXIX.



Mounds and Mound-Builder's Skull.

The remaining one and three-fourths feet of material was yellow earth, not packed.

Scattered through the mound were numerous pieces of oak charcoal.

In various parts of the mound were local deposits or "patches" of ashes, and underneath them thin, deeply-stained layers of ashes and earth, having the appearance of being stained by the decomposition of flesh.

In mound No. 9 were found the remains of four bodies.

The teeth and bones of two of these individuals showed them to have been well advanced in years, while the third body was that of a person of middle age, and the fourth that of a subject somewhat younger.

The lower jaw of one of these individuals was very large and strong, with the angles much straightened. All the teeth, with one exception, were well preserved, although much worn on the crowns.

One large molar, which was otherwise sound, had a decayed cavity in the cervix 3 mm. in diameter.

Although we have personally examined the teeth of many mound-builders, this is almost the first example of decayed teeth belonging to these people which has come under our observation. Another interesting and finely preserved lower jaw obtained from this mound had a breadth measuring, from exterior to exterior, at the angles twelve and one-half centimeters.

This maxillary had apparently been fractured during life; and this may perhaps account, in part, for its great width.

The angle of the jaw was very low and much straightened.

At the time of death only the incisors and canines remained; all the other teeth had been lost, and the alveolar processes either wholly or in part absorbed.

All the bodies had been placed in a sitting posture in the centre of the mound, on a small hillock, one and one-half feet in height, composed of ashes and earth.

Although all the bodies had been buried in the flesh, still a portion of the skull of one individual had been much charred by fire before being in the mound.

The first one and one-fourth feet of material composing the mound was soft, yellow earth, similar to that constituting the other mounds; and the remaining one and three-fourths feet was of the same material, mixed with ashes, and made quite hard.

Disseminated through the mass were a few small pieces of charcoal.

In mound No. 10, which was about forty-five feet in diameter and

three feet in height, were discovered the remains of three persons, the bones being in a better state of preservation than in any of the other mounds of the group explored.

First, there had been reared, from the ordinary black surface-soil of the vicinity, a small hillock, one foot in height; and on this were placed in a sitting posture, with the feet drawn under them, the three bodies.

One finely preserved lower jaw found in this mound was very massive and broad, and contained large, finely preserved teeth. The teeth in this specimen were all worn quite flat upon the crowns; and this remark applies to the incisors and canines, as well as cuspids and bicuspids.

In this case it is shown that the masticating surface of the upper jaw fitted perfectly that of the lower one.

The incisor teeth did not lap, but impinged on each other at their cutting edges, like the molars. This form of teeth is not peculiar to the mound-builders, however, but is characteristic of savage races generally.

The material composing this mound, although analogous to that of other mounds of the series, was not *packed* around the bodies.

It was plainly evident that much less care was exercised in this burial than in any of the others. Gathered facts, moreover, demonstrate that this mound, as well as some of the others, was erected long anterior to Nos. 3 and 4. Some years ago mound No. 2 was graded down by Mr. R. H. Gordon (on whose farm all the mounds are located) in making an excavation for a cellar.

The structure of the mound was similar to that of No. 4, although much smaller. On the original surface had been placed, in a sitting posture, one or two bodies.

The crania and many bones of the bodies are reported to have been in a good state of preservation.

Mound No. 1 is now twenty-two feet in diameter and one foot in height; but owing to the fact of its having been cultivated over for more than ten years, its original height has been somewhat reduced and its diameter slightly increased.

A few inches above the surface which environed the mound was discovered, upon exploration, a thick bed of charcoal, and a log over eight feet in length and twelve inches in diameter, which had been thoroughly burned.

This coal was mostly in a fine state of preservation. The wood used was of the same species of oak as now occupies the surface of the region. In this mound was observed scarcely a trace of ashes.

From all the evidence gained it was plain to be seen that this was not a place of sepulture; but, on the contrary, was a place where wood was burned for the purpose of obtaining ashes to aid in the construction of at least some of the burial mounds.

No fire had been used on any of the burial mounds examined, both the charcoal and ashes found in them having been brought in from some other place.

All the remains found in the mounds had been buried in the flesh, the earth in contact with the bodies being deeply stained by their decomposition.

As before stated, the earth from which the mounds were constructed was a yellow, clayey material, unlike that of the surface of the region, and had been brought in from some other place, at a greater or less distance from the mounds.

No relics of any description were found with the bodies exhumed, and as for field relics, none are reported from the region.

Owing to the lack of time, mounds Nos. 5 to 8 have not, as yet, been explored.—CLEMENT L. WEBSTER, *Charles City, Iowa.*